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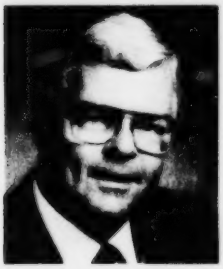


Canadians count on transportation to keep them in motion and in touch. The national transportation system serves to build and strengthen this country as well as stimulate regional development and economic growth.

Transport Canada and the transportation community have a duty and a responsibility to ensure that the Canadian transportation system is safe, efficient and economical. It is a challenge that requires innovation and the best modern technology.

Transport Canada's Transportation Development Centre is helping to meet this challenge through a systematic program of transportation research and development (R&D). The Centre carries out its R&D program in cooperation with other federal departments, with provincial governments and with the transportation industry. As described in this ninth edition of the Project Directory, this joint effort has produced impressive results.

Together the Transportation Development Centre and its transportation R&D partners are facing the challenge of ensuring a transportation system that serves Canadian needs safely, efficiently and reliably. Together we can achieve this goal.

The Honourable John C. Crosbie
Minister of Transport

Preface

This is the ninth in a series of project directories describing the research and development activities of Transport Canada's Transportation Development Centre (TDC). This volume covers selected projects active during the period June 1985 to June 1986.

The directory is organized according to the principal thrust areas of TDC's research and development program in transportation technologies: rail, surface, air and marine.

Each project description briefly relates the rationale for the work, its objectives and the methodology for achievement of these objectives. Also given are an account of completed work, the name of the performing organization and titles of reports.

The project description is accompanied by supplementary information consisting of the work schedule, project and file numbers, funding sources and the name of the project officer in charge.

Table of Contents

Introduction 1

Rail Technology 7

Rail Electrification
- Quebec North Shore Railways: Rationalization Study 9
- Railway Electrification Demonstration 11

Motive Power Technology
- Medium-Speed Diesel Combustion Research 13
- Locomotive Fuel Saving 14
- Microprocessor Control of AC Locomotive Propulsion Electronics 15
- Railway Motive Power Development Study 16

Freight Car Systems
- Thermal Tank Car Response Analysis: Phase 2 17
- Tank Explosion Suppression 19
- Frame-Braced Freight Car Truck Development 21
- In-Service Radial Truck Evaluation: Phase 3 23
- Train Resistance Reduction 24

Train Systems
- Train Dynamics Simulation 25
- High Productivity Integral Train 27
- Evaluation of Event Recorders 29

Track and Infrastructure
- Track Structure Research Program 31
- Rail Wear Measurement 33
- Wheel/Rail System Test Facility 34
- Induction Hardening of Carbon Steel Rail 35
- Rail Grinding Optimization: Phase 3 37
- Rail Wear and Fatigue Model 39
- TDC/CP Cooperative Rail Research Program 41

Signalling, Communications and Control
- Train Control: Test-Bed System Development 42
- End-of-Train Monitoring System 43
- Railway Colour Light Signal 45
- Radio-Operated Power Switch 46

Rail Passenger Technology
- Prototype Railbus Vehicle: Conceptual Design 47
- BRE-Leyland Railbus Evaluation and Demonstration 49
- Testing of WCSS Railbus 51
- Rail Passenger Vehicle for Remote Services 52

Surface Technology 55

Highway Transportation
- Testing of Acoustic Emissions of Compressed Gas 57
- Vehicle Weights and Dimensions Program: Static Testing 59

- Vehicle Weights and Dimensions Program: Impact Analysis 60
- Truck Seat Vibration Study 61
- Liquid Tanker Stability Research 62
- Carbon Dioxide Refrigeration System for Trucks 63
- Synthetic Lubricant Test Program 64
- Heavy Vehicle Fuel Consumption Research 65
- Convertible Flatbed/Dry Bulk Trailer 67
- Costing Methods for Trucking Operations 68
- Quality of Air in Buses: A Study 69
- Articulated Bus Demonstration 71
- Advanced Bus Suspension Program 72

Urban Transportation

- Incrementally Variable Transmission Dynamics 73
- Incrementally Variable Transmission for Urban Buses 74
- Propane in Diesel Engine Cylinders 75
- Improved Propane Refuelling for Road Vehicles 76
- Aluminum/Air Battery for Vehicles 77
- Large Moli Battery Development 79
- Microcomputer-Based Integrated Traffic System 80
- Freeway Traffic Flow Management 81
- Integrated Transportation Information System (ITIS) Demonstration 83
- Standards for Left-Turn Signal Phasing 84

Transportation for the Elderly and the Disabled

- SCAT Demonstration 85
- Lightweight Electric Wheelchair Development 86
- Hybrid Wheelchairs: A Study of Regulatory and Safety Issues 87
- Accessible Commuter Rail for Disabled Persons 88
- Student Design Competition for Pedestrian Crosswalks 89
- Communication Aids at Transportation Terminals 91
- Portable Train-Based Wheelchair Lift 92
- Transfer Chair Evaluation 93
- Multi-Purpose Vehicle Development 95
- Computerized Scheduling/Brokerage Demonstration of Special Public Transit Services 97

Tracked, Levitated Vehicles

- Canadian Maglev System Development 99
- Advanced Linear Induction Motor and Propulsion Control Research 101

Off-Road and Solids Pipeline

- Slurry Pipeline Manual 102
- Arctic Snowmobile Evaluation 103
- Aerobac Cost Study 104

Multimodal Transportation

- Transportation Management Game: JET-SET 105
- Grain Terminal Simulation Project 107
- Rail Network Simulation for Port Operations 108

Air Technology 111

Navigation

- Microwave Landing System: Microstrip Antenna Development 113
- Microwave Landing System: Ground Test Facility 114
- Computer-Aided Learning for Air Traffic Control Electronics Technicians 115
- ATC Workstation Development: Phase 1 117
- Prototype Application of Expert Systems 118

Airports

- Explosives Detection Technology Assessment 119
- Automatic X-Ray Screening for Carry-on Baggage 120
- Airport Pedestrian Flow Model 121

Safety and Regulation

- Voice Advisory Information System for Helicopters 122
- Smoke Mask Criteria 123
- Instrument Impact Analysis 125

Airframe and Propulsion

- Advanced Composite Wing Design 127
- Nacelle Airflow Optimization 129
- Fuel-Efficient STOL Aircraft 130

Marine Technology 133

Arctic Navigation Support Systems

- In-Air Acoustic Detection of Icebergs 134
- Sonar Detection of Icebergs: An Assessment 135
- Ultrasonic Doppler Velocimeter for Icebreakers 136
- Evaluation of Ice Thickness Sensors 137
- Ice Navigation Workstation Development 139
- Human Factors Research: Arctic Ship Safety 140

Ice-Transiting Ship Technologies

- MV *Arctic* Testing Program: Spring 1986 Voyage 141
- USCGC Polar Class Program 1985/86 143
- Arctic Ship Technology 144
- Icebreaker Bow Development 145
- Automated Ice Ramming System Development 146
- Segmented Model Ice Tests: Phase 2 147
- Ice Strength Indexer 149
- Ice Ridges and Ship Performance 150
- Ice Class Ships: Added Mass Studies 151
- Ice Forces on Nozzle Propellers: An Engineering Analysis 153
- Protection of Propellers in Ice 154
- Ship's Steering Gear Ice Load Modelling 155

General Marine Research

- Welding Methods for Aluminum 157
- Ice Loads on Fishing Vessels 158
- Dynamic Stability of Ships 159

- SWATH Ships: Feasibility Study 161
- Energy-Effective Tug/Barge Configuration 163
- Motion Compensation for Marine Crane Operations 164
- Detection of Small Objects at Sea 165
- Permanent Bubbler System Evaluation 167
- Fibre Optics for Marine Systems 168

Report Listing 169

Introducing the Transportation Development Centre

The Transportation Development Centre (TDC) was formed by Transport Canada in 1970 to study, promote and manage the application of science and technology towards a safer, more efficient and effective Canadian transportation system. Located in Montreal, TDC administers an ongoing program of research and development (R&D) activities, all of which are contracted out to the private sector.

TDC mission

TDC's mission is two-fold:

- to provide components of Transport Canada with specific data, research, and demonstration projects to assist them in their operational, regulatory, policy planning and evaluation functions;
- to undertake exploratory research and development addressing requirements in transportation technology and systems that are long-range, high-risk and national in scope.

R&D program

TDC's R&D program covers all modes of transportation: rail, surface, air and marine. Included in the surface mode is road, off-road and solids pipeline transport. The major emphasis of the centre's R&D program is on rail freight and Arctic marine, each of which accounts for about 25 per cent of TDC's annual R&D expenditures. Special attention is also being given to an R&D program aimed at improving transportation accessibility for elderly and disabled Canadians.

TDC uses the consultative process to ensure that R&D projects are relevant to Transport Canada's needs and respond to the priorities of the transportation industry. To identify R&D thrust areas, TDC consults with modal advisory boards composed of representatives of marine, air, rail and surface industries.

In implementing its R&D program, TDC relies on a multi-disciplined staff of professionals. Each TDC project officer is given complete responsibility for achieving individual project objectives within approved budgets and schedules. To assist the staff and ensure effective program direction and control, TDC has established a computerized management information system (MIS). The MIS is integrated with the Transport Canada finance function and provides up-to-date information on project status and program costs.

TDC Organization

TDC is organized into five operating divisions: Current Technology, Advanced Technology, Technology Applications, Transportation Systems Technology, and Research Analysis and Special Programs.

Current Technology projects are aimed at improving existing transportation technology. These projects involve developing prototypes and conducting test programs. Follow-on work for current technology development frequently takes the form of in-service evaluation by transport operators.

Advanced Technology projects investigate new concepts and innovative technical solutions that promise to overcome shortfalls in systems using conventional technology. Developments resulting from these projects are supported by quantitative assessments of the economics and user-acceptability of the technology.

Technology Applications projects involve practical testing and evaluation of technological developments, including the systems analysis studies needed to establish a base for assessment and comparison. Technology demonstration projects are directed towards introducing new methods, equipment and systems on an experimental basis.

Transportation Systems Technology projects are aimed at developing major new Canadian transportation systems. The division emphasizes marine transportation in the Arctic and off the East Coast, and off-road transportation in remote regions. The interface between operator and technology and the ergonomic design of transportation equipment and systems are considered.

Research Analysis and Special Programs involves operational planning for TDC as well as program evaluation and technology forecasting. The emphasis here is on transportation for the elderly and the disabled and on urban transportation.

Library

TDC also administers a comprehensive transportation technology library. The library has approximately 15,000 books and reports, 5,000 documents on microfiche, an audio-visual collection and Statistics Canada publications. As well, the library subscribes to over 500 periodicals. Underlining the library's effectiveness is on-line access to three data-base systems: DIALOG, ORBIT and CAN/OLE. Supplementing these systems, the library has on-line access to the holdings of about 500 Canadian libraries through the University of Toronto Automation System (UTLAS).

Funding

The centre's research projects are funded in one of two ways: entirely from TDC's R&D budget, or on a cost-shared basis with other Transport Canada components, other federal departments, industry or provinces.

Following is a list of abbreviations used in the directory to identify some of the funding sources:

ADMA: Transport Canada, Assistant Deputy Minister, Aviation Group
ADMM: Transport Canada, Assistant Deputy Minister, Marine Group
ADMS: Transport Canada, Assistant Deputy Minister, Surface Group
CCG: Canadian Coast Guard
DGRD: Transport Canada, Director General, Research and Development
DGSP: Transport Canada, Director General, Surface Policy
DND: Department of National Defence
DFO: Department of Fisheries and Oceans
DRIE: Department of Regional Industrial Expansion
DSS: Supply and Services Canada
EDA: Transport Canada, Executive Director, Airports Authority Group
EMR: Energy, Mines and Resources Canada
ERDA: Economic Regional Development Agreement
NRC: National Research Council Canada
TDC-AAMP: Controlled allotment of funds allocated by the Transport Canada Marine Group to TDC for its Augmented Arctic Marine Program
TDC-ARFP: Controlled allotment of funds managed by TDC for its Augmented Rail Freight Program
TDPP: Transportation for the Disabled Program, funded by the Cabinet Committee for Economic and Regional Development

Publications

Each TDC project is documented by a technical report. A list of recent publications, along with ordering procedures, appears on page 170.

Unsolicited Proposals

TDC also considers unsolicited proposals for R&D projects. These submissions are received through the Unsolicited Proposal Program administered by Supply and Services Canada. For more information, contact: Director, Programs Branch, Science and Professional Services Directorate, Supply and Services Canada, Hull, Quebec, K1A 0S5. Telephone: (819) 997-7428.

RAIL TECHNOLOGY

Rail Technology

A safe and efficient rail transportation system is vital to the country. For Canadian industry, the cost of delivering goods by rail, especially bulk commodities, influences their competitiveness in both domestic and foreign markets. For the travelling Canadian public, safe and reliable rail service is essential.

To help meet the needs of these distinct user groups, TDC funds research and development projects in rail freight and rail passenger transportation. These projects are undertaken in conjunction with railways, railway equipment manufacturers, consulting companies and research organizations.

Rail Electrification

TDC's research and development in rail electrification has contributed to placing Canada in the forefront of 50 kV, commercial frequency distribution systems. The 132-kilometre Tumbler Ridge-Anzac electrified rail section of B.C. Rail is providing important operating experience and technical data on electrification in a Canadian context. Through arrangements with B.C. Rail, the experience is being documented as a demonstration project.

Motive Power Technology

The development of technology to meet the future requirements of Canadian railways for productive and fuel-efficient motive power is the main objective of this area of research. Projects include: reducing fuel consumption of locomotives through more efficient management of motive power, applying microprocessor-based controllers to locomotive power control units and forecasting motive power needs to the year 2000 in light of emerging technologies.

Freight Car Systems

TDC is supporting research in this area to enhance the performance of Canadian freight cars in terms of safety, energy efficiency, maintenance and life-cycle costs. Projects include improving tank car safety and reducing train resistance. A major group of projects is concerned with truck technology.

Train Systems

Safety, energy efficiency and productivity of train systems can be improved through application of emerging technologies. With this in mind, TDC is supporting the development of a train dynamics simulator for exploring the longitudinal behaviour of trains. TDC is also supporting research to design new, high productivity integral trains for dedicated use in bulk and intermodal service. Other research includes the evaluation of locomotive event recorders for accident investigation and training.

Track and Infrastructure

In cooperation with Canadian railways, TDC is supporting research to improve railway track structure design, materials and maintenance practices. The goal of this research is to improve train performance as well as extend the life of track structure. The projects, involving laboratory experiments and field tests, are aimed at developing safe and cost-effective track infrastructure maintenance procedures and better track components and materials.

Signalling, Communications and Control

Increased safety, reliability and productivity of railway operations can be realized through the development and use of improved signalling, communications and control equipment. TDC has underway several research and development projects with this objective in mind. In particular, TDC is involved with developing: advanced train control systems based on communications and computer technology; an end-of-train unit capable of providing data on operating parameters at the rear of the train to the locomotive engineer; a new railway light signal using light-emitting diodes; and radio-operated control for power switches.

Rail Passenger Technology

TDC supports technology and system developments that will improve the economic efficiency and level of service of intercity rail transportation in Canada. Current projects include technical and in-service testing of a railbus to serve communities where conventional rail service is too costly and suitable alternative transportation is not available.

Quebec North Shore Railways: Rationalization Study

Description

The railways in the region of Quebec north of the St. Lawrence River are experiencing economic difficulties due to the decline of the mining industry. Two major railway companies, the Quebec North Shore and Labrador (QNS&L) and the Cartier railways, serve the north-south routes in the north shore region. East-west lines are served by smaller companies: Northern Land, Arnaud, and Wabush Lake. As output from the iron ore mines has dropped off, these railways have been operating at less than full capacity. As a result, transportation costs have risen, which has in turn affected the ability of Quebec's mines to compete on the world market.

The objective of this project is to study ways of using the existing rail infrastructure in the north shore region more effectively. Electrification, route changes and operational consolidations will be considered.

Progress to June 1986

Data collection for the study has started.

Contractors

Canadian Pacific Consulting Services Ltd., Montreal, Quebec
CANAC Consultants Ltd., Montreal, Quebec

Report

None to date

Schedule: March 1986 — March 1987

Funding: TDC —	$200,000
Transports Québec —	$200,000
Total —	$400,000

Project Number: 6647
File Number: D 1465-477-1
Project Officer: C. Alfred Versailles

View of electric locomotive on Tumbler Ridge line showing the 50 kV catenary. The electrified line was inaugurated in May 1984.

Railway Electrification Demonstration

Description

Electrification offers important benefits to Canadian railways, including: increased line capacity, improved locomotive adhesion and speed on gradients, lower maintenance costs, reduced energy consumption and the elimination of such site problems as tunnel ventilation and fuel distribution.

The objective of this project is to document B.C. Rail's demonstration electrified branch line at Tumbler Ridge. The demonstration provides operating experience with state-of-the-art, 50 kV electrification technology under Canadian environmental conditions. Researchers are documenting every phase of the demonstration, from site selection and material procurement to operational evaluation.

The electrified demonstration line was inaugurated in May 1984. It is 132 km long and links B.C. Rail's main line at Anzac to a new coal mine at Tumbler Ridge. The line carries 8.5 million tonnes of coal annually in unit trains. Two major tunnels, 6 km and 9 km long, have ascending grades against loaded trains. A recent study showed that electrification of the tunnel segments alone has resulted in substantial savings by eliminating the need for tunnel ventilation.

The demonstration included acquisition of electric locomotives, installation of a 50 kV/60 Hz catenary system, and construction of a series-capacitor station and a substation for connection to B.C. Hydro. The LICS (Location, Identification, and Control System) was installed on one locomotive and along a section of the line to evaluate the electronic signalling system.

Progress to June 1986

The project is complete. Researchers have produced an audio-visual presentation entitled *Tomorrow's Railway Today*, a 16 mm film entitled *995 Days*, and several reports.

Contractor

British Columbia Railway, Vancouver, British Columbia

Reports

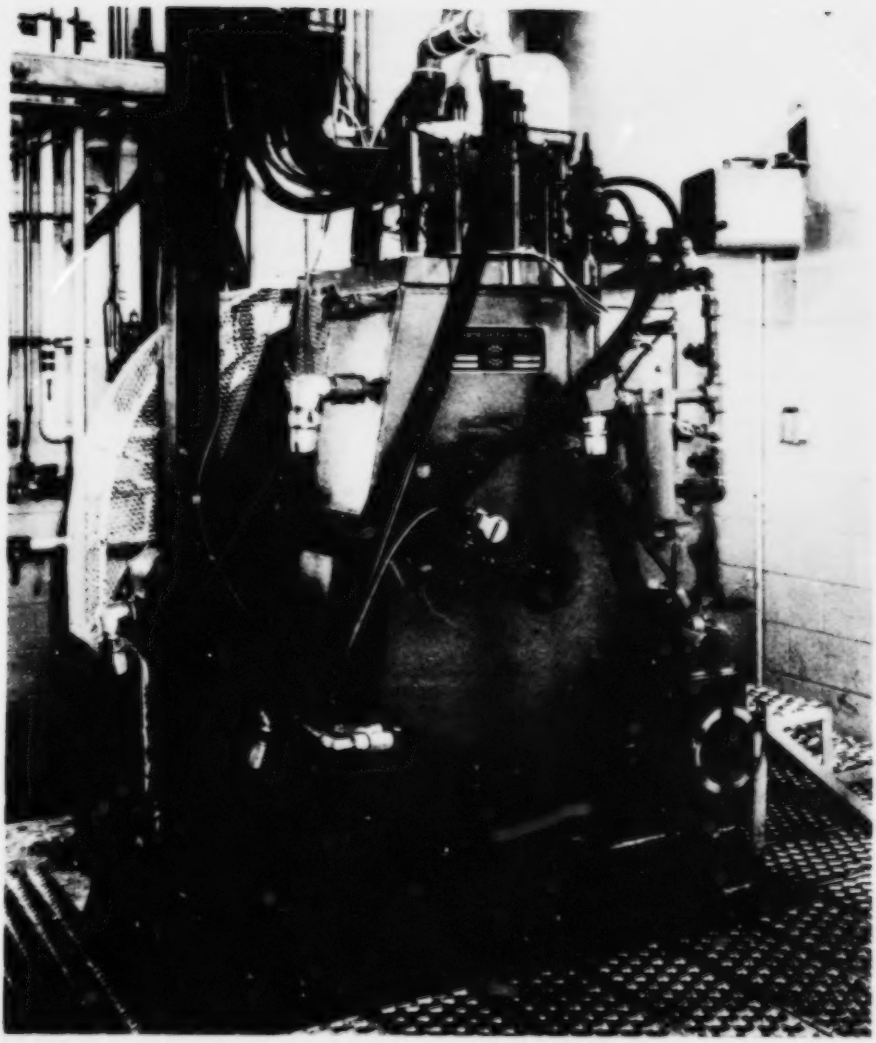
TP 7625E, Electrification of the Tumbler Ridge Branch Line, British Columbia Railway, 1986.

TP 4950E, Railway electrification: engineering and sourcing overhead contact system, 3 volumes, Canadian Pacific Consulting Services Ltd., 1983.

TP 4899E, British Columbia Railway Tumbler Ridge branch line electrification power supply system design, Canadian Pacific Consulting Services Ltd., 1983.

Schedule: November 1983 — March 1986
Funding: TDC-ARFP — $510,000

Project Number: 4960
File Number: D 1465-317-18
Project Officer: C. Alfred Versailles



The B2400 single-cylinder research engine in test cell

Medium-Speed Diesel Combustion Research

Description

The performance of a diesel engine is greatly dependent on the type of fuel it burns. Research on the combustion phenomena of diesel engines is important because Canadian railways may be using alternative or off-specification fuels in the future. Many of the tests necessary to fully understand combustion are costly and time-consuming to conduct on multi-cylinder engines. For this reason, researchers have designed two single-cylinder test engines based on the configuration of two modern diesels, the B2400 and 251 models manufactured by Bombardier Inc., of Montreal.

The objective of this phase of the project is to make the test engines and related facilities operational. The engines will be qualified for research applications, and performance correlation factors will be developed between the single-cylinder and multi-cylinder engines.

The single-cylinder version of the B2400 engine will be used to observe parameters relating to the cylinder head and liner, fuel injection equipment, valve system, piston, and combustion effect. The single-cylinder 251 engine will test a new cylinder head design and the optimization of the piston bowl and injector nozzle.

The single-cylinder test facility will not only save time and money compared with multi-cylinder testing; it will also offer engine manufacturers, operators, and lubricant producers flexibility in test programs that is not available elsewhere.

Progress to June 1986

The test facilities containing the single-cylinder engines were commissioned in early 1985. The qualification tests are underway but will not be completed during this phase of the project. Design work has also been completed for a mechanism to replicate on a single-cylinder diesel engine the effects of the turbochargers used in multi-cylinder engines. A subsequent phase of the project is now being defined to complete the qualification tests, the studies on performance correlation between single- and multi-cylinder engines and the incorporation of hardware to replicate turbocharger effects.

Contractor

Bombardier Inc., Montreal, Quebec

Report

None to date

Schedule: January 1985 — September 1986

Funding: TDC-ARFP —	$289,942
EMR-Energy R&D Program —	$340,058
Bombardier Inc. —	$120,000
Total —	$750,000

Project Number: 6303
File Number: D 1465-372-2-3
Project Officer: Roy S. Nishizaki

Locomotive Fuel Saving

Description

Improved train handling techniques, articulated trucks, and improved braking have all contributed to reducing the fuel consumption of locomotives. Yet fuel costs continue to be a major item in railway operating budgets. Significant amounts of fuel are used to keep diesel locomotives idling outdoors during the winter. This is necessary because diesel engines do not start easily during cold weather, and antifreeze is not used in locomotive cooling.

The Quebec North Shore & Labrador Railway (QNS&L) has designed and built a system that shuts down a locomotive and automatically restarts it when the engine temperature falls below a certain level. A prototype unit installed on one of the railway's locomotives realized a fuel saving of five per cent.

The objective of this project is to reduce railway fuel consumption through more efficient management of locomotive operation, and specifically by reducing idling time.

Researchers are developing the QNS&L concept. They are using microprocessor and fibre optic technologies to improve the reliability of the automatic restarting system. Fibre optic cables eliminate malfunction due to electrical interference, and microprocessor controls provide greater flexibility.

Progress to June 1986

The prototype system installed on the QNS&L locomotive is being tested and modified. When the system is fully operational, several pre-production systems will be manufactured and installed on locomotives, and fuel savings will be evaluated.

Contractor

DSL Dynamic Sciences Ltd., St. Laurent, Quebec

Report

None to date

Schedule: December 1984 — March 1987

Funding: TDC-ARFP —	$115,034
DSS —	$126,373
EMR-Energy R&D Program —	$100,000
Total —	$341,407

Project Number: 6314
File Number: D 1465-448-1
Project Officer: Doug W. Dibble

Microprocessor Control of AC Locomotive Propulsion Electronics

Description

Since 1979, TDC has been supporting the development of AC locomotive propulsion. The greater power offered by AC propulsion — up to 1000 hp per axle — would significantly improve the performance of Canadian diesel-electric locomotives. However, several obstacles must be overcome before this technology can be used by Canadian railways. The leading problem is the need for AC-DC-AC control electronics. (Existing electronic controls use discrete components.) European AC-DC-AC technology cannot be directly transferred to Canada because of differences in equipment configurations and operating practices.

The objective of this project is to develop a microprocessor- based controller for an AC-DC-AC power control unit and to test the system in operational service on diesel-electric locomotives. A microprocessor-based control system will offer several advantages: it will be flexible, allowing design changes during the development process; it will have automatic fault diagnosis, which will simplify maintenance and repair procedures; and, it will be smaller, lighter and less expensive than existing electronic control systems.

Successful completion of this project will significantly improve the attractiveness of AC propulsion for Canadian railways and hasten its introduction into service.

Progress to June 1986

Researchers at the University of Toronto have designed the software for the microprocessor control system. Field trials will be conducted using a CP locomotive during the summer of 1986.

Contractor

BBC Brown Boveri Canada Inc., Pointe-Claire, Quebec

Subcontractor

University of Toronto, Toronto, Ontario

Report

Draft, Software development for a microprocessor- based controller for AC-DC-AC diesel-electric freight locomotive power control unit, University of Toronto.

CP locomotive fitted with AC traction motors and microprocessor controller

Schedule: June 1982 — December 1986
Funding: TDC-ARFP — $481,949

Project Number: 4560
File Number: D 1465-371
Project Officer: C. Alfred Versailles

Railway Motive Power Development Study

Description

By the year 2000, most of Canada's railway motive power equipment will have to be upgraded. TDC has supported development work on electric and diesel-electric locomotives and on AC traction motors. To choose the best development strategy, the railway industry now requires a comprehensive definition of Canada's motive power needs to the end of the century.

The objective of this project is to study future motive power needs and to evaluate current and emerging technological developments throughout the world.

Researchers will first define the anticipated changes in railway operations that will affect the choice of motive power. Second, they will review developing motive power technology, including truck design, transmission systems, traction motors, locomotives powered by conventional and alternative fuels, and adhesion enhancement techniques. Finally, they will assess the value of various technologies in light of anticipated Canadian needs.

The findings of this study will help Canadian railways to better plan their equipment acquisition strategies to the year 2000.

Progress to June 1986

A literature search has been conducted. Investigators are discussing planned operational and equipment changes with CN Rail, CP Rail and B.C. Rail.

Contractor

Queen's University, Canadian Institute of Guided Ground Transport, Kingston, Ontario

Report

None to date

GM SD40-2 locomotive currently in use on Canadian railways

Schedule: December 1985 — June 1987

Funding: TDC-ARFP —	$112,500
EMR-Energy R&D Program —	$112,500
Total —	$225,000

Project Number: 6562
File Number: D 1465-467-1
Project Officer: C. Alfred Versailles

Thermal Tank Car Response Analysis: Phase 2

Description

Researchers at the University of New Brunswick's Fire Service Centre have been studying how tanks and their contents respond to external fires. The knowledge gained by these studies will help reduce the incidence and impact of explosions involving rail and road tank cars transporting liquefied petroleum gas.

The first phase of tests was conducted in a special cylindrical tank equipped with plexiglass end walls and monitoring instruments. The tests revealed that the thermal hydraulic behaviour of hazardous liquids heated in tanks vented with pressure relief valves is extremely complex. Three factors were found to have a profound effect on tank behaviour during external fires: subcooling as a result of thermal stratification; pressure and temperature response to release of the pressure valve; and, boiling and swelling phenomena.

The current project is the second phase of this long-term research program. The objective of the second phase is to analyze specific phenomena that are crucial to the development of a reliable model. These phenomena include: the action of subcooled and saturated two-phase boundary layers; the effect of pressure relief valve orientation, heat flux and lading fill on pressure relief; the effect of using high-heat-flux inner surfaces for vapour space protection; and, vapour space heat transfer characteristics.

Progress to June 1986

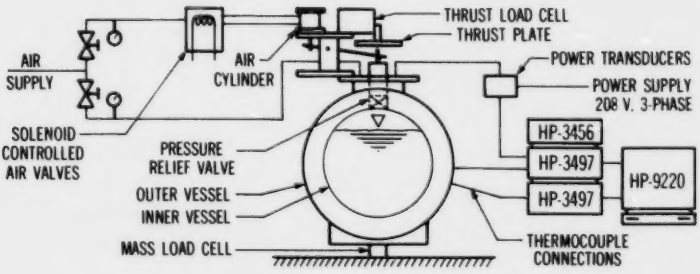
An opportunity for scientific exchange occurred at the beginning of the second phase of the program when the principal researcher at the university was invited to work at the Explosion and Flame Laboratories of the Health and Safety Executive in Buxton, England, for eight months. He has now returned and is proceeding with research on the TDC project.

Contractor

Fire Science Centre, University of New Brunswick, Fredericton, New Brunswick

Report

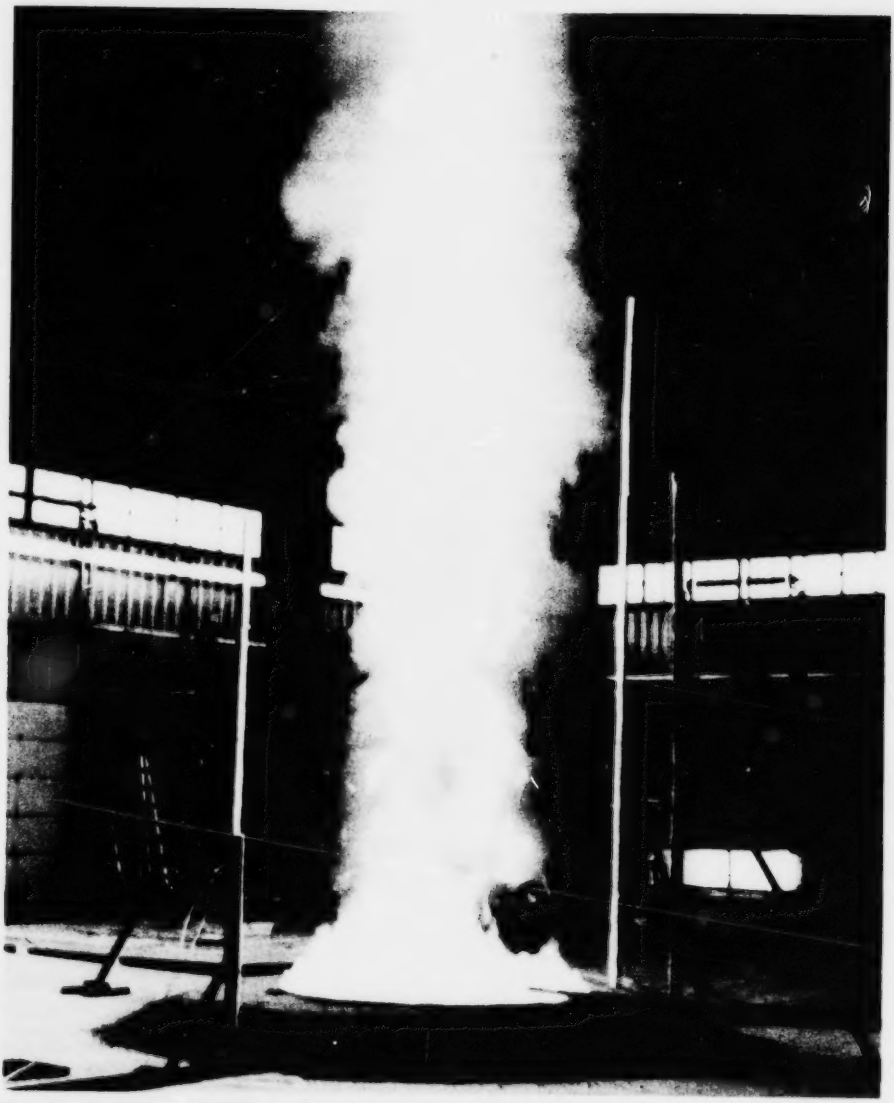
Draft, Tank car thermal response analysis, nine volumes, Fire Science Centre, University of New Brunswick.



Schematic diagram of experimental facility at the University of New Brunswick

Schedule: April 1985 — March 1987
Funding: TDC — $120,000

Project Number: 6480
File Number: D 1465-302-6-6
Project Officer: Doug W. Dibble



Experiment to measure the thermal effects of a burning relief valve flare on a tank engulfed in a pool of fire

Tank Explosion Suppression

Description

Using rail and road tank cars to transport liquefied petroleum gas is hazardous. As use of tank cars for this purpose increases, ways must be found to reduce the risk of explosion after collision or derailment. Explosions result when a fire around the car raises the wall temperature of the tank to the point of rupture. Researchers have yet to produce a design for a tank car protection system that meets the operational requirements of carriers.

This project is aimed at perfecting a new design for a protection system. The system consists of an internal shell separated from the outer tank wall by an annular space. When the tank is heated, a pressure differential forces the liquefied petroleum gas and gas vapour to flow from the inner shell through the annular space, to the relief valve; in passing through the annular space, the gas helps to cool the tank wall.

Currently, tanks containing pressurized dangerous liquids are protected with pressure relief valves and exterior thermal insulation covered by a steel jacket. The proposed design has three potential advantages:

- it is not subject to detachment and damage under normal use as is the external insulation currently used.
- it ensures liquefied gas and gas vapour flow through the relief valve even when the tank is rolled on its side; and,
- it offers faster venting, thus reducing the risk of explosion.

The project involves a feasibility study and preliminary mechanical and thermal design studies. A cost/benefit analysis will ensure that the proposed design will provide at least equal performance at less cost than the current thermal insulation system.

Progress to June 1986

The mechanical design study is complete. Results indicate the design is feasible and offers a potential for cost savings. Work continues on the thermal design study. A final report is expected in March 1987.

Contractor

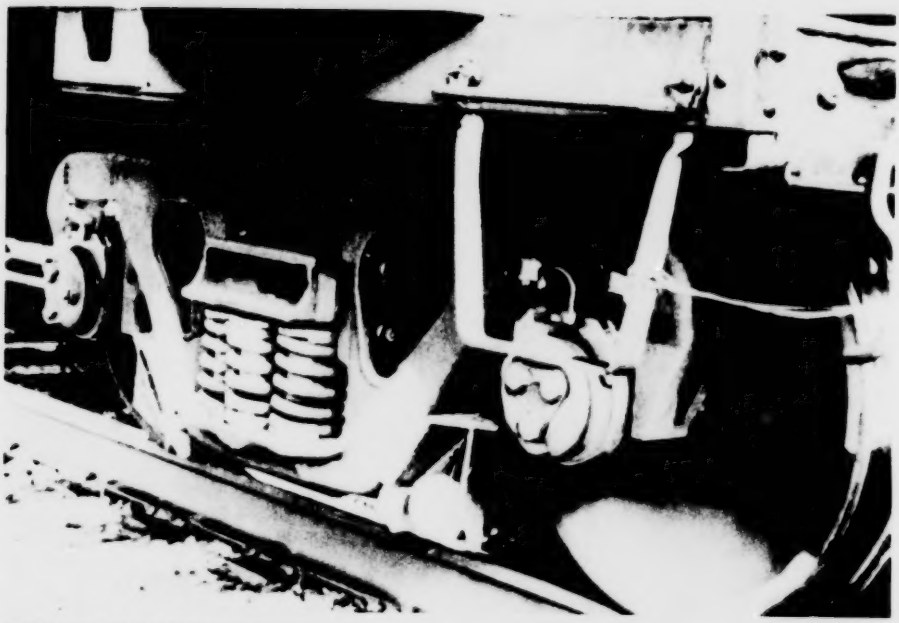
W.R. Davis Engineering Ltd., Ottawa, Ontario

Report

None to date

Schedule: December 1985 — March 1987
Funding: DSS — $87,500

Project Number: 6477
File Number: D 1465-302-9
Project Officer: Doug W. Dibble



Gondola car with retrofitted frame-braced truck

Frame-Braced Freight Car Truck Development

Description

Standard three-piece freight car trucks suffer from design deficiencies that prevent satisfactory curving performance without excessive wheel flange forces. They are also vulnerable to hunting (lateral instability) in lightly loaded cars travelling faster than 80 km/h. These shortcomings cause accelerated rail and wheel wear, higher fuel consumption and increased track gauge and alignment problems. The hunting also results in operational limitations and accelerated deterioration of truck components.

Recently developed steerable trucks, using cross-braced techniques, permit the wheelset to align itself radially with the curve. This decreases the angle of attack between the vertical plane of the wheel and the rail, thus correcting the curving deficiencies found in the standard trucks.

A frame-braced concept has also been developed which provides similar benefits to steerable trucks, but which is simpler and less costly.

The objective of this project was to assess the potential of the frame-braced freight car truck as an alternative to the cross-braced steerable truck.

Progress to June 1986

The project is complete. Four standard freight car trucks were retrofitted to frame-braced design. The frame-braced and standard trucks were installed on four gondola cars, instrumented and field-tested by the Ontario Northland Transportation Commission and the Burlington Northern Railroad. Computer modelling was used to assist in economic projections for the trucks.

Test measurements indicated that frame bracing increased the stability of the three-piece truck by about 22 per cent and decreased the angle of attack by 25 per cent. Researchers predicted that this could result in reductions in wheel tread wear of 40 to 75 per cent for unloaded cars and up to 62 per cent for loaded cars. Flange wear reductions of up to 42 per cent were also predicted. The economic analysis concluded that frame-braced trucks could pay for themselves within four years when used more than 80,000 kilometres per year.

Contractor

Transportation Technology Ltd., Kingston, Ontario

Report

Draft, Demonstration of rail freight trucks using frame-bracing technology, Transportation Technology Ltd.

Schedule: November 1982 — June 1986

Funding: TDC-ARFP —	$104,000
Ontario Ministry of Transportation and Communications —	$ 46,250
Ontario Ministry of Northern Affairs —	$ 50,000
Total —	$200,250

Project Number: 4729
File Number: D 1465-384
Project Officer: Doug W. Dibble

View of elastometric pad and pedestal clearances of radial truck

Unit coal train equipped with radial trucks passing over rail wear measuring test station on Tumbler Ridge line in British Columbia

In-Service Radial Truck Evaluation: Phase 3

Description

In the late 1970s, CP Rail began a test program to obtain quantitive data on the performance of various radial trucks. The results of this work to date have demonstrated that radial trucks offer: increased fuel savings due to decreased rolling resistance; decreased wheel flange wear; and, decreased maintenance of truck components. These trucks can be effective in reducing lateral curving forces and angle of attack while maintaining stability at high speeds. (Angle of attack indicates the degree of wheel/rail misalignment, and thus of the contact surface between wheel and rail, a main factor in the wear process of both.)

At present, considerable research effort by Canadian railways is being directed at testing two radial truck designs, Dofasco's DR-2 and the Barber Radial. Two other designs, a rigidized elasto-cushion truck and a frame-braced truck, developed by Transportation Technology Ltd. of Kingston, Ontario, are also being evaluated to determine wheel wear, hunting and curving performance.

The aim of this project is to obtain quantitative data on the comparative performance of conventional and radial axle freight car trucks with respect to wheel wear, operational characteristics and component performance. Trains using conventional trucks will also be compared with trains using radial axle trucks for fuel consumption and short-term rail wear.

Progress to June 1986

One half of a unit coal train has been equipped with Barber Radial trucks and the other half with DR-2 trucks. This train has accumulated over 70,000 kilometres of operation.

The DR-2 truck used in a unit coal train in previous tests required a modification to a steering arm. Fatigue tests were completed on the new DR-2 steering arm and the truck has been returned to service.

The Barber Scheffel truck under test in previous phases of this project has almost 640,000 kilometres of service and is continuing operation in revenue service in a unit coal train.

The rigidized elasto-cushion truck, with 96,000 kilometres of service in previous evaluations, was further tested. Stress measurements conducted on the shear plate of the truck during revenue service tests in some cases exceeded 69,000 kPa (10,000 psi).

Five bathtub coal cars have been equipped with Transportation Technology Ltd.'s frame-braced trucks and introduced into revenue service testing in unit coal trains in the Pacific Region of CP Rail.

Contractor

Canadian Pacific Limited, Montreal, Quebec

Report

None to date

Schedule: June 1985 — July 1986

Funding: TDC —	$ 86,000	**Project Number:** 6468
CP Rail —	$ 86,000	**File Number:** D 1465-108-11
Total —	$172,000	**Project Officer:** Doug W. Dibble

Train Resistance Reduction

Description

The introduction of more sophisticated train simulation models has generated a need to develop a basic theory of causal relationships affecting the resistance of trains to forward motion. The Canadian Institute of Guided Ground Transport evaluated the Association of American Railroads' train energy model and existing railway data to determine the current level of knowledge about train resistance. The study identified knowledge gaps in this field.

The current project intends to fill some of these gaps by obtaining and analyzing train resistance data through field tests.

The CN Rail dynamometer car is being run on revenue trains in service between Montreal and Toronto. The instrumentation on the car was augmented by the National Research Council to allow data to be recorded in digital format as well as the strip-recorder format normally used by CN. The instruments are recording: relative airspeed and direction; train speed; drawbar force; throttle position; air brake pressure; dynamometer car lateral inclination; and, time. A voice update for information on position, temperature and anomalies is provided for.

The results will be used to check existing theories on train resistance causality.

Progress to June 1986

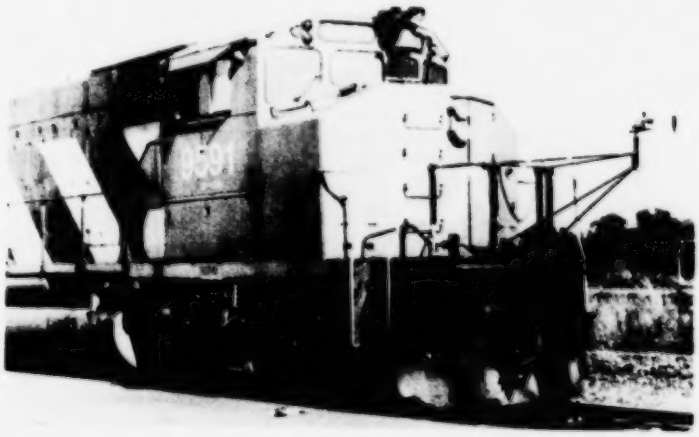
Data continues to be collected and analyzed. A report is expected in September 1986.

Contractor

Queen's University, Canadian Institute of Guided Ground Transport, Kingston, Ontario

Report

None to date



CN locomotive equipped with airspeed measuring device for train resistance tests

Schedule: June 1985 — September 1986
Funding: TDC — $127,830

Project Number: 6473
File Number: D 1465-6-7-2
Project Officer: Roy S. Nishizaki

Train Dynamics Simulation

Description

North American railways are designing new equipment and developing new operating procedures in an effort to save fuel. New equipment is reducing vehicle tare weight, aerodynamic drag and rolling resistance. New operating procedures include such train handling techniques as dynamic braking.

The effect of these changes on trains is not fully understood, but they are thought to be creating operating conditions that may generate higher in-train forces. The railways must evaluate the consequences of new equipment or operating procedures before fully implementing them.

In this project, researchers designed a train action model to simulate the operation of railway trains in real time. A VAX 11/780 computer and terminal were used to control and operate the model. The simulation program permitted researchers to determine the dynamic longitudinal forces at couplers and the longitudinal acceleration of cars within the train.

Progress to June 1986

The simulation program is functioning. The Dynamic Sciences Ltd. program is expected to be used to predict the performance of a train equipped with lockable draw gear. The Railway Advisory Board has been looking for a suitable model to investigate this gear design. As well, the simulation program will probably be attractive to railroads looking for a better way of investigating train-handling procedures and circumstances following accidents.

Contractor

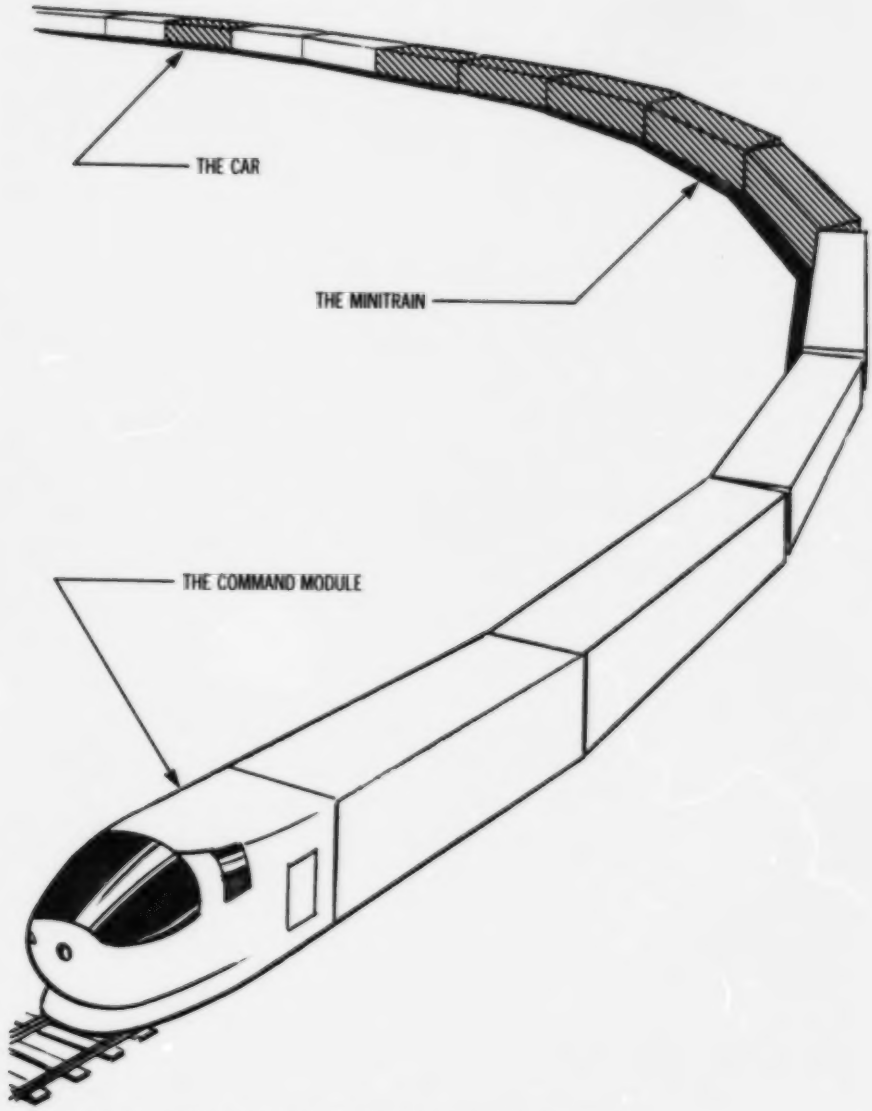
DSL Dynamic Sciences Ltd., St. Laurent, Quebec

Report

None to date

Schedule: December 1982 — September 1986
Funding: TDC-ARFP — $376,586

Project Number: 4813
File Number: D 1485-106-12
Project Officer: Doug W. Dibble



Artist's drawing of advanced high productivity integral train incorporating: on-car distributed propulsion; lightweight cars — approximately 60 per cent of the weight of existing intermodal lightweight cars; self-steered axle sets; and a low-cost command module to replace locomotives.

High Productivity Integral Train

Description

A new generation of freight train is being envisaged to transport bulk and intermodal commodities. These High Productivity Integral Trains (HPIT) are intended to minimize cost per net ton-mile. HPITs use such innovative features as distributed power, articulated cars, advanced truck design and slackless drawbars. Projected intermodal and bulk commodity volumes are sufficient to permit the new trains to avoid the design constraints of car interchange rules and hump-yard operations. The expected market potential for HPITs in both the intermodal and bulk commodity configuration is estimated at 1,900 train sets by 1995.

The HPIT program was initiated by the Association of American Railroads, through a request for concept proposals to both Canadian and U.S. industry. Transportation Technology Ltd., of Kingston, Ontario, was the sole Canadian respondent.

The objective of this TDC project was to support the development of the Canadian HPIT concept. Researchers developed operating specifications for bulk commodity and intermodal HPITs and established a concept definition for both types of train. The design goals included: improved system reliability; reduced derailment risk; improved ride and stability; optimized load/tare ratios; better utilization of fixed plant operations for railways; and, reduced operating costs of 50 per cent for intermodal operations and 35 per cent for bulk commodity operations.

Progress to June 1986

The project is complete. The report describes two train concepts, a Near Term concept and an Advanced Train concept.

The Near Term concept includes both container and trailer train system options. It offers significant operating economies in the 20 per cent to 30 per cent range. The concept incorporates existing railway technology, including microprocessor controls, single-axle and self-steered two-axle trucks and a variable-length drawbar.

The Advanced Train concept offers potential cost reductions of up to 50 per cent. This concept uses technology not currently in use in the rail freight industry, including: independent AC drive on car axles; lightweight, monocoque construction for car bodies; resilient suspension to allow movement on curves; and, a compliant, air-bearing system for loading and unloading.

The report is being studied by major North American railways. Manufacturing and testing of a prototype HPIT would be a logical second phase of the project.

Contractor

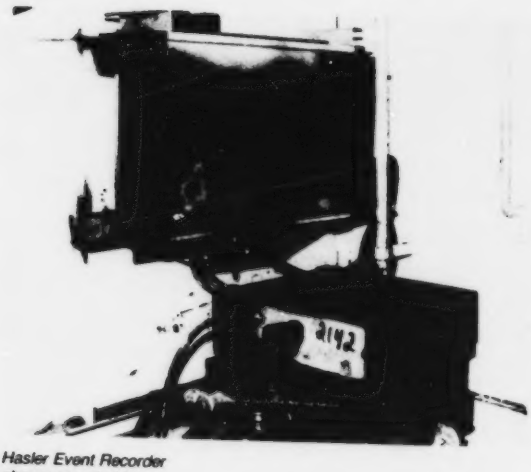
Transportation Technology Ltd., Kingston, Ontario

Report

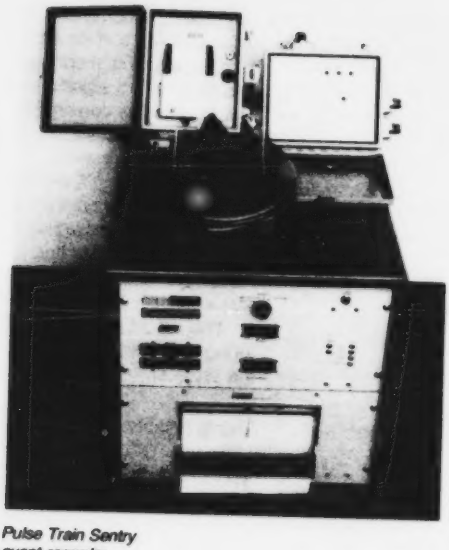
TP 7119E, High productivity integral train conceptual designs, three volumes, Transportation Technology Ltd., December 1985.

Schedule: October 1984 — April 1985
Funding: TDC-ARFP — $395,550

Project Number: 6340
File Number: D 1465-453
Project Officer: Doug W. Dibble



Hasler Event Recorder shown mounted in hood of CP locomotive



Pulse Train Sentry event recorder

Evaluation of Event Recorders

Description

The Canadian railway industry has expressed strong interest in using train data recording systems, also known as locomotive event recorders, for accident investigation. However, there has been little operating experience with these recorders in Canada.

The objective of this project was to conduct field tests on two event recorders to determine their suitability. CN Rail and CP Rail tested the Pulse Train Sentry and the Hasler Event Recorder, using specifications prepared by TDC. Both recorders are already on the market.

Progress to June 1986

The project is complete. Each field test included performance tests, accident simulation tests and analysis of reliability and maintenance characteristics.

CN Rail tested the Pulse Train Sentry on 10 locomotives over 15 months. Using cassettes holding 48 to 50 hours of data, this device records elapsed time, speed, throttle setting, brake pipe pressure, independent brake cylinder pressure, locomotive-initiated emergency, whistle and distance. No operational or maintenance problems were encountered. Evaluators made several recommendations for design changes to facilitate installation in locomotives. They also recommended that the scale used on the strip chart be expanded to facilitate detailed examination.

CP Rail tested the Hasler Event Recorder on eight locomotives over four months. This device records speed, throttle position, horn, dynamic brake, brake pipe pressure, independent brake operation, locomotive-initiated emergency, real time and distance. No operational or maintenance problems were encountered. Evaluators also conducted an accident simulation test and found the recorder was extremely accurate. The report concluded that the recorder could survive under the operating conditions on a diesel locomotive and record reliable data.

Contractors

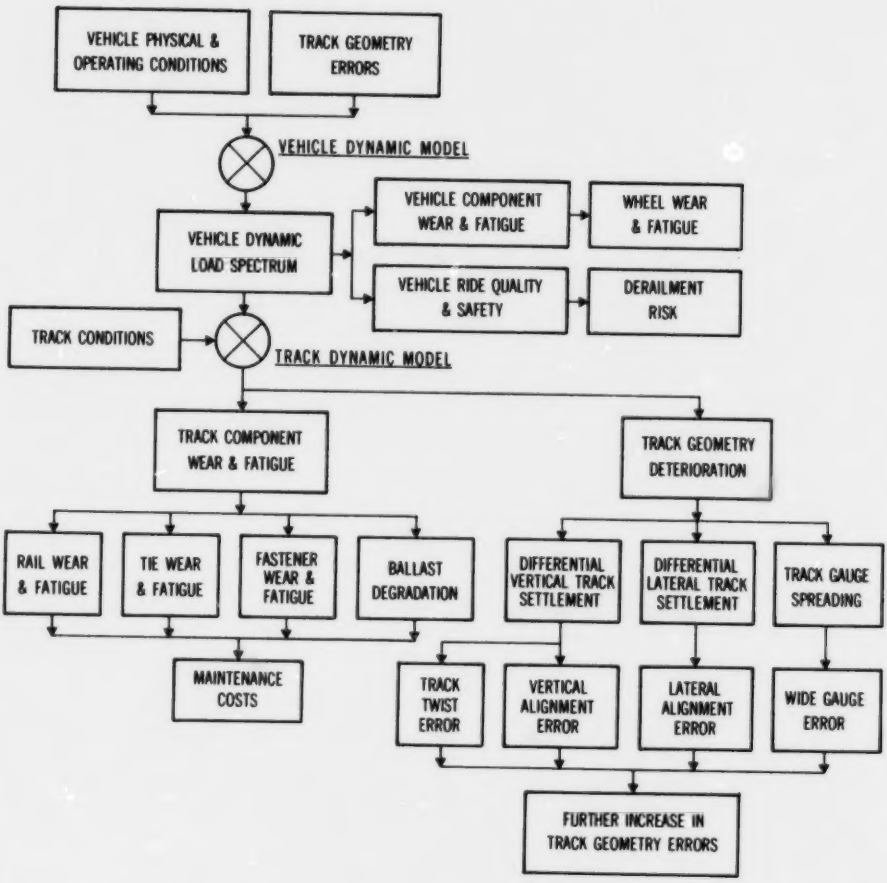
Canadian National Railway, Montreal, Quebec
Canadian Pacific Rail, Montreal, Quebec

Reports

TP 7240E, CP locomotive event recorder evaluation, CP Rail, 1985.
TP 6219E, Locomotive event recorders — field evaluation: Pulse model 48H8-C-10, CN Rail, 1984.

Schedule: March 1983 — March 1986
Funding: EMR-Energy R&D Program — $118,000
CN Rail (in kind) — $ 25,000
CP Rail (in kind) — $ 25,000
Total — $168,000

Project Numbers: 4746, 4899
File Numbers: D 1465-390-3/4
Project Officer: Doug W. Dibble



Track structure research program: block diagram illustrates interactive processes linking vehicle dynamic forces to deterioration of track components and geometry.

Track Structure Research Program

Description

This three-year program has two broad objectives: first, to evaluate the use of a new generation of geotextile fabrics in track rehabilitation; and, second, to investigate the dynamic response of railway track to the high-speed, heavy axle loads of passenger and freight traffic over time.

Current Canadian specifications for railway ballast and geotextiles are based on the research of Dr. G.P. Raymond of Queen's University into the stresses and deformations in railway track structure and support under dynamic and static loads.

During the first two years of the current program, researchers developed a new geotextile specification, new acceptance testing methods based on the latest technology, and a material specification for aggregate sub-ballast. Earlier work by the Canadian Institute of Guided Ground Transport at Queen's University produced analytical models for track component wear and fatigue, and road maintenance costs.

The objective of the final year of the program is to upgrade and calibrate these models using recent data on track dynamics, track geometry deterioration and track maintenance costs. New data will be collected where knowledge gaps are found during the analysis of available information.

The findings of this research will provide railway track engineers with a better understanding of the effects of vibration on rail fastenings, ties, ballast, subballast and subgrade material, and lead to improved track design and maintenance practices on Canadian railways.

Progress to June 1986

The new geotextile material specified features non-woven fabric layers made from monofilament polyester yarn treated with a low-modulus binder or latex-based acrylic resin; the yarn has a strength of not less than 3.8 grams of force per denier. The specifications for subballast material complement the specifications already available for the ballast material used above the geotextile fabric.

Contractor

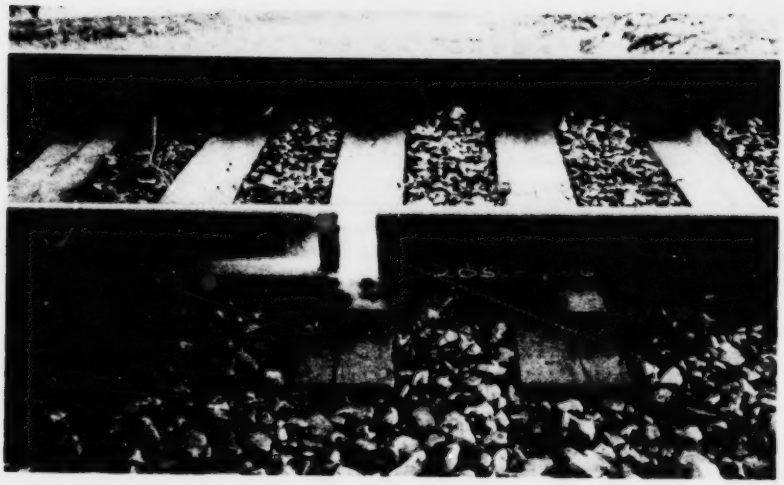
Queen's University, Canadian Institute of Guided Ground Transport, Kingston, Ontario

Reports

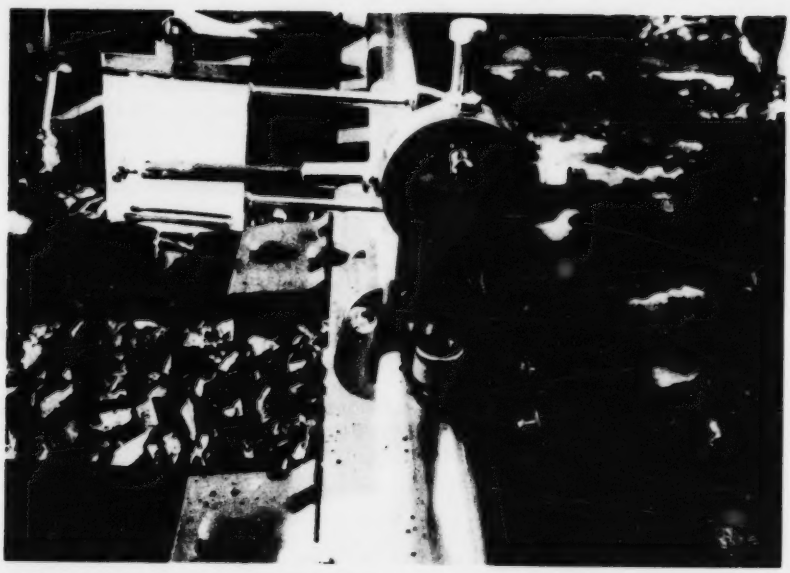
TP 7417E, CIGGT track research program: interim report, November 1984-November 1985, Queen's University, Canadian Institute of Guided Ground Transport, 1986.
TP 7383E, Subballast and geotextiles for railway track support separation applications, Queen's University, Canadian Institute of Guided Ground Transport, 1985.
TP 6204E, CIGGT track research program: interim report, November 1983-November 1984, Queen's University, Canadian Institute of Guided Ground Transport, 1984.

Schedule: November 1983 — October 1986
Funding: TDC-ARFP — $245,000

Project Number: 6059
File Number: D 1465-401-2
Project Officer: Wayne G. Rowan



Witness Groove test site



CN Rail's Yoshida profilometer measuring rail wear

Rail Wear Measurement

Description

Self-steering trucks for railway freight cars are known to significantly reduce wheel wear. Some tests have shown wear reduction ratios of three to one over wheels on conventional trucks. As yet there are too few fleets of self-steering trucks in service to provide conclusive evidence from the field that there is a similar reduction in rail wear. Exact data on rail wear is necessary to demonstrate that the savings accruing from the use of self-steering trucks are sufficient to offset the initial additional cost of the trucks.

An opportunity to test the equipment in service arose in 1984, when B.C. Rail inaugurated the Tumbler Ridge line. Almost 90 per cent of the Tumbler Ridge fleet is using the DR-1 self-steering truck.

The objective of this project is to measure the reduction in rail wear on the Tumbler Ridge line that can be attributed to the use of the DR-1 truck.

Rail wear will be measured over a three-year period. Several rail research organizations are participating in the project, and three separate rail-wear measuring techniques are being used. CN Rail's profilometer is being used to measure rail profiles twice a year at 228 test sites. The Association of American Railroads has provided equipment and personnel to measure rail temperatures before, during, and immediately after the passage of a train. The equipment will be calibrated, then researchers will study the correlation between temperature rise and rail wear and determine the most effective type of rail lubrication. The National Research Council's Western Laboratory is helping to record and analyze data collected from the Witness Groove test of rail wear. This test involves scratching the rail surface, making epoxy replicas of the scratched surface at various time intervals and analyzing the replicas to determine rail wear.

Control data will be obtained at a site with similar traffic patterns but with a fleet using standard, 100-ton, three-piece trucks.

This project is expected to provide data for an assessment of rail-wear cost savings resulting from the use of DR-1 trucks. It will also allow researchers to compare data from several different rail-wear measuring techniques.

Progress to June 1986

The test sites have been selected and equipment is in place. Most measurements began in October 1985.

Contractor

British Columbia Railway, Vancouver, British Columbia

Report

None to date

Schedule: June 1985 — June 1988
Funding: TDC — $94,725

Project Number: 6312
File Number: D 1465-317-24
Project Officer: Doug W. Dibble

Wheel/Rail System Test Facility

Description

TDC helped develop terms of reference for a full-scale, multi-purpose test facility for new rail equipment. The terms of reference were developed into a preliminary concept by DSL Dynamic Sciences Ltd. of St. Laurent, Quebec. The concept was further developed by the National Research Council (NRC) into a preliminary design for a full-scale, multi-purpose wheel/rail test facility.

The objective of the current project is to complete the design of the test rig and to manufacture and assemble it. The rig will permit full-scale tests of wheel/rail interaction, brakes and bearings under controlled conditions. The rig features a standard wheel-set with the rail element represented by a roller. It will be housed in a building constructed by NRC at its Vehicle Dynamics Laboratory in Uplands, Ontario. It will also be portable, allowing it to be transported to the cold chamber of the NRC Climatic Engineering Facility for research requiring controlled environmental conditions.

The new test facility will provide industry, regulating bodies and governments with the ability to respond more efficiently to the research and development needs of Canadian railways.

Progress to June 1986

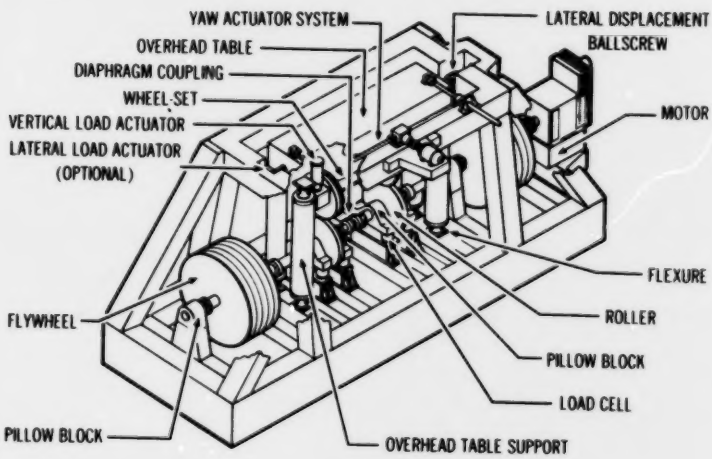
The building to house the test rig is complete. Work continues on the conversion of the design specifications into a satisfactory preliminary design that does not jeopardize either the functional flexibility or the mechanical integrity of the unit.

Contractor

National Research Council, Ottawa, Ontario

Report

None to date



Artist's sketch of test facility showing load frame driveline and flexibly mounted overhead table. The wheel-set under test is positioned above the set of rollers and representative loads and positions are applied.

Schedule: June 1985 — March 1988

Funding: TDC —	$300,000
NRC —	$680,000
Total —	$980,000

Project Number: 6484
File Number: D 1465-380-2
Project Officer: Roy S. Nishizaki

Induction Hardening of Carbon Steel Rail

Description

Rail replacement is a major cost component in maintaining railway track. Steel costs alone are currently estimated at 300 million dollars per year. Hardening of the head of the rail provides greater resistance to wear, and can extend the life cycle of track.

The objective of this project was to produce in a laboratory a hardness pattern in 67.46 kg/m carbon steel rail to meet railway specifications, using electrical induction heating and air quenching techniques.

Progress to June 1986

The project is complete. Several configurations of inductors were constructed and tested at various frequencies. An air quench tunnel was designed and constructed as an integral part of a test rig.

Short sections (0.9 m) of carbon steel rail were processed. Fine pearlite grain structures were achieved in the head hardened zone. Hardness patterns met the specification requirements. Dimensional stability of the test sections was maintained.

Since the completion of this preliminary research funded by TDC, the contractor has obtained private-sector support and has built a larger prototype capable of processing multiple 11.89-m lengths of rail. The contractor has informed TDC that rail processed on the new prototype meets the required specifications and maintains distortion within acceptable limits. Full-scale applications at steel mills and stringing plants are planned for the near future. Designs for mobile devices for rail hardening in situ are also underway.

Contractor

Permatrack Systems Inc., Vancouver, British Columbia

Report

Not releasable at this time

Schedule: January 1984 — July 1985

Funding: TDC —	$20,000
DSS —	$26,000
Total —	$46,000

Project Number: 6136
File Number: D 1465-436
Project Officer: N.R. Gore

View of rail wear gauge used in the field to establish the condition of the rail and to monitor rail grinding operations

Rail Grinding Optimization: Phase 3

Description

TDC has been supporting research using conventional rail grinding equipment to develop a ground rail profile that will reduce rail corrugation, shelling and side wear.

During the first phase of this research program, field trials were conducted to formulate rail grinding specifications for optimum track curving performance. Researchers developed an asymmetrical ground rail profile design incorporating preventive maintenance techniques to extend rail life in curves and decrease wheel wear and fuel consumption.

The second phase of the program validated the ground rail profile through field tests. Fifteen curves were selected for validation tests, and three control curves were used for comparison. The recommended grinding techniques were also compared with conventional grinding practices for CP Rail trackage.

The objectives of the third phase of the program are:

- to monitor the grinding operations for consistency, and the design profile for long-term performance;
- to develop new criteria for wear limits on continuous welded rail;
- to develop a simple gauge for field verification of grinding performance; and,
- to examine the implications of introducing a preventive maintenance grinding program involving more frequent grinds using fewer and finer grinding stones operated at higher speeds.

Researchers will apply the preventive program to three test sites on B.C. Rail track, while three similar sites on CP Rail track will be subjected to the current, less frequent grinding practice. Rail head loss, surface cracking, rail lubrication, and subsurface cracking and plastic flow will be monitored. Cut-out cross sections of the rail from all six sites will be analyzed in a National Research Council laboratory.

Progress to June 1986

The test sites have been selected.

Contractor

Queen's University, Canadian Institute of Guided Ground Transport, Kingston, Ontario

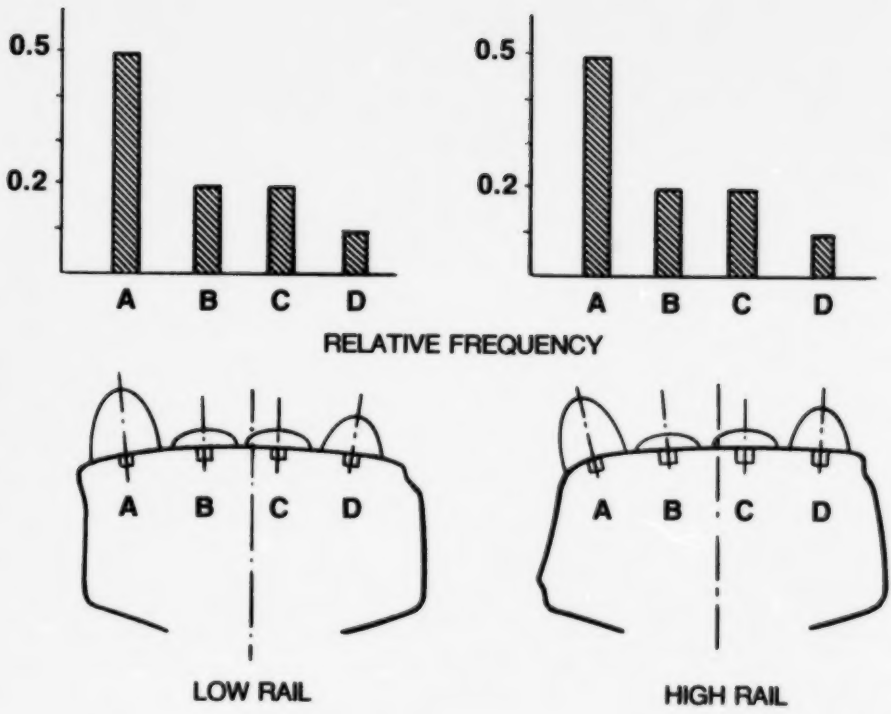
Report

None to date

Schedule: May 1986 — May 1989

Funding: TDC —	$136,000	
CIGGT —	$178,000	
B.C. Rail —	(in kind)	
NRC —	(in kind)	
CP Rail —	$ 57,500 +	(in kind)
Total —	$371,500	

Project Number: 6631
File Number: D 1465-368-4
Project Officer: Wayne G. Rowan



Frequency histogram of rail/wheel contact for naturally worn rail in 8° curve

Rail Wear and Fatigue Model

Description

Some of the current research on railways is focusing on extending the operational life of rails. One area of this research is concentrating on the wear and fatigue of wheels and rails which can be attributed to heavily loaded cars.

The objective of this project was to establish a unified rail wear and fatigue theory that takes into consideration the parameters influencing the wheel/rail system under different lubrication regimes. Three sets of interrelated parameters — mechanical, metallurgical and rheological — were considered.

This joint project of the Association of American Railroads and TDC was conducted by the National Research Council, Western Laboratory in Vancouver and by the University of Rhode Island. The theory resulting from this project will be useful in predicting rail life as well as determining efficient railway maintenance procedures.

Progress to June 1986

The project is complete. A major result of the work was a proposal for a new method of rail grinding aimed at preventing the growth of rail corrugations in curved and tangent track. The proposed method would remove no more than two or three thousandths of an inch of metal from the rail top running surface, compared with the 70 thousandths that must be removed once corrugations have formed. Using the preventive grinding method, well-lubricated, premium-grade rails should remain free from surface cracks and corrugations. A presentation of the work was made to B.C. Rail and CN Rail, and they have agreed to test the theory.

In related work, the National Research Council developed a prototype tribometer to experimentally determine the creep coefficients between various wheel and rail materials. The tribometer will be used during upcoming field tests to establish such parameters as the creepage/traction force relationship and the efficiency of trackside lubricators.

Contractor

National Research Council, Ottawa, Ontario

Report

TP 6939E, Establishment of quantitative wear and fatigue model for railway rail subjected to heavy traffic conditions and different lubrication regimes, National Research Council, 1985.

Schedule: March 1985 — March 1986

Funding: TDC-ARFP —	$ 40,000
NRC —	$100,000
Total —	$140,000

Project Number: 6155
File Number: D 1465-366-4
Project Officer: Doug W. Dibble

View of end of concrete track slab and test cylinders

TDC/CP Cooperative Rail Research Program

Description

Since 1973, TDC and Canadian Pacific Limited have been cooperatively researching the interaction between trains and track in order to better develop, operate and maintain railway track and equipment.

In the latest phase of research, investigators continue to evaluate truck stabilization devices, rail, concrete slab track for tunnel installation and wheel shelling. New studies include measurement of wheel/rail force and angle of attack in tangent track conditions.

Laboratory and field tests and computer modelling are being used to meet these objectives.

Progress to June 1986

The report of the 1984-85 research program has been published. Reported items include: use of the Witness Groove Method to measure rail wear; an evaluation of the wear performance of Japanese head-hardened rail; results of tests of paved concrete track slab in the Mountain subdivision and of concrete ties on a bridge in the Winchester subdivision; and, a preliminary evaluation of piggyback-car truck stabilizing devices.

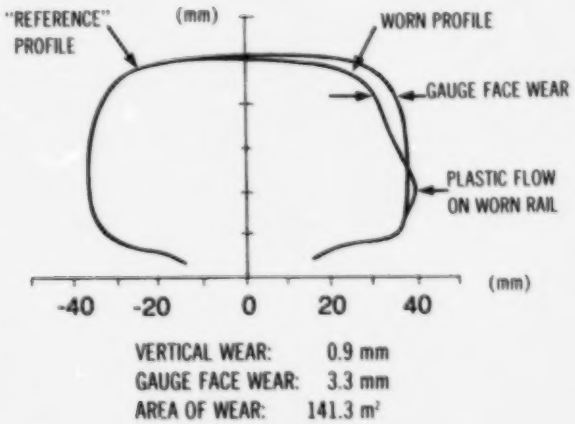
For the 1985-86 program: test strings of experimental Algoma low-alloy rail and of the Nippon Steel Company's Superrail have been installed in the Pacific Region, and in-service comparative wear testing has begun; field tests continue on the truck stabilizing devices; and, angle of attack measurements have been taken using a modified measuring system developed in 1985.

Contractor

Canadian Pacific Limited, Montreal, Quebec

Report

TP 6660E, Track/train dynamics, volume 5, 1984, Canadian Pacific Limited, 1985.



Comparison of original and worn profiles of Japanese Superrail from high rail in 8.5° curve

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Schedule: March 1985 — December 1986

Funding: TDC —	$119,000	**Project Number:** 6451
CP Ltd —	$119,000	**File Number:** D 1465-403-5
Total —	$238,000	**Project Officer:** Doug W. Dibble

Train Control: Test-Bed System Development

Description

Locating, identifying, and controlling trains from computerized dispatch centres has been a major goal of research and development in advanced train control systems. During the past five years, B.C. Rail has been experimenting with a radio-linked location, identification, and control system (LICS) that provides dispatchers with continuous real-time monitoring of individual trains. Although the system is suitable for operational implementation, a number of technical changes are needed to improve capacity and reliability.

Advanced train control systems are also being studied jointly by the Railway Association of Canada and the Association of American Railroads. It is therefore appropriate that further development of the LICS be compatible with the needs of both Canadian and U.S. railways.

This project has two objectives: to demonstrate a train control system based on an enhanced LICS concept; and to develop a testing ground for evaluating advanced train control systems.

B.C. Rail will update the specifications for a LICS, defining host computer, locomotive display, communication network, associated software and diagnostic software. A testing ground will be developed on B.C. Rail's Squamish subdivision and the electrified line of its Tumbler Ridge subdivision.

This project is part of a continuing effort to introduce new communication and micro-electronic technologies into rail operations.

Progress to June 1986

Work on this project has just begun.

Contractor

British Columbia Railway, Vancouver, British Columbia

Report

None to date

Schedule: April 1986 — November 1986

Funding: TDC —	$145,000
TDC-ARFP —	$ 75,000
Total —	$220,000

Project Number: 6622
File Number: D 1465-317-27
Project Officer: Micha Avni

End-of-Train Monitoring System

Description

Railways in Canada and the United States are interested in using end-of-train monitoring equipment to improve train productivity and safety. The monitoring system could eliminate the need for an end-of-train crew, resulting in improved operating efficiency.

TDC has supported the design and development of an end-of-train monitoring system, known as Digitair, which automatically monitors brake-line pressure at the end of the train and displays pressure readings in the locomotive cab. The computerized system incorporates a rugged rear unit that can be easily and securely mounted on the end coupler.

The objective of this project is to improve the Digitair system to meet the latest requirements of the Association of American Railroads and of Canadian railways for trains operating without cabooses. These requirements include: a remotely activated brake operated by a radio signal from the locomotive; sensors to detect rear car motion; a device to detect drafting of the rear car; and, modification of the software to comply with the communications protocol set by the Association of American Railroads.

Progress to June 1986

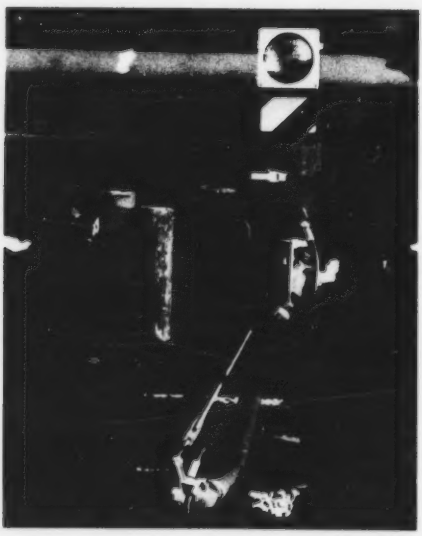
The Digitair system has been modified and is currently being tested by both CN Rail and CP Rail on track in western Canada.

Contractor

Glenayre Electronics Ltd., Vancouver, British Columbia

Report

None to date



End-of-train unit mounted on coupler of end car

Schedule: May 1984 — July 1986
Funding: TDC — $250,000

Project Number: 6271
File Number: D 1465-408
Project Officer: Micha Avni

LED-array light signal

Railway Colour Light Signal

Description

North American railway signal lights have one lamp, one lens and a mechanical device to move one of three colour glasses into the beam of light. Mechanical malfunctions, and therefore incorrect signals, are rare; however, when the lamp burns out, no signal is produced at all. Trains approaching unlit signals are required to come to a full stop, and may proceed only after specific safety procedures have been followed.

To overcome these shortcomings of railway signals, TDC is collaborating with CN Rail in developing a non-mechanical signal with built-in protection against lamp burn-out. About 300 new signal units are used annually by Canadian railways.

An earlier phase of the project confirmed the feasibility of applying new technology to the design problem. Researchers presented two promising concepts, one for retrofitting existing signals, the other for a stand-alone unit suitable for new installations. Both concepts use solid-state, light-emitting diodes (LEDs) in place of conventional lamps. Banks of red, yellow and green diodes provide colour selection.

The objective of the latest phase of the project was to build prototypes of promising configurations of these concepts for subsequent test and evaluation by CN Rail. The control system must meet the standards set by the Association of American Railroads (AAR).

Progress to June 1986

The project is complete. Two prototype retrofit units and a breadboard model of the stand-alone design were built. Both designs failed to meet AAR standards. However, TDC is monitoring developments in LED technology in the belief that the signal designs can be improved to meet industry standards.

Contractor

W.R. Davis Engineering Ltd., Ottawa, Ontario

Report

Non-releasable

Schedule: August 1984 — September 1985
Funding: TDC-ARFP — $123,889

Project Number: 6292
File Number: D 1465-378-3
Project Officer: Wayne G. Rowan

Radio-Operated Power Switch

Description

Railways across North America use voice messages transmitted by radio to control train routing in areas where traffic density cannot justify the expense of centralized traffic control signalling. In such areas, referred to as manual block system (MBS) territory, a central dispatcher communicates directly with train crews by radio. Train position is reported by the crew and routing instructions are given by the dispatcher, based upon safety rules established for each line.

Switches in MBS territory are controlled manually by train crews. Thus, trains must stop twice when entering a siding: once to switch onto the siding, and again to return the switch to the main-line position after the train has entered the siding.

The objective of this project is to develop a system that would permit the use of powered switches controlled by radio from the train locomotive. The work is spread over three phases. The first phase, design and prototype, addresses: operating rules and regulatory issues; engineering and laboratory testing of the power switch machine and the communication software; and, a simulated operation test. Future phases will include field testing and operational demonstrations.

Use of radio-controlled power switches will reduce fuel consumption by requiring fewer stops; increase safety by allowing switch position to be verified by radio; accommodate trains without cabooses since crews could control switches from the locomotive; and, increase the capacity of MBS lines by speeding up operations.

Progress to June 1986

Specifications for the system have been developed. These specifications have been approved by CN Rail and CP Rail. The Canadian Transport Commission has been advised of progress on the work. The contractor's MITAP-1200 mobile information terminal and processor is being adapted for use for locomotive-wayside data communications over existing voice-radio channels.

Contractor

Signalcom Canada Corporation, Brampton, Ontario

Report

None to date

Schedule: February 1986 — September 1986
Funding: TDC — $98,000

Project Number: 6628
File Number: D 1465-473
Project Officer: Micha Avni

Prototype Railbus Vehicle: Conceptual Design

Description

In many remote communities in northern Canada, the railway offers the only means of long-distance, all-weather ground transportation. But most communities are too small to justify operation of conventional, 80-passenger rail cars. A highway coach modified to run on rail tracks could provide a feasible alternative. It would cost less to acquire, operate and maintain than current rail equipment.

A railbus acceptable for general passenger service in Canada is not available. TDC, in cooperation with Transport Canada's Rail Passenger Directorate and the province of Manitoba, has been testing a converted Western Flyer bus in rail operation (see page 51). However, this vehicle was intended only as a test-bed to explore the institutional, operational and safety issues involved in operating a non-conventional vehicle such as this.

Railbuses are available overseas; in fact, TDC is currently evaluating a British light diesel railbus for remote Canadian service (see page 49). However, because foreign railbuses have not been developed for use under Canadian conditions, they may not be able to operate on tracks built for heavy freight operations or withstand the rigours of Canadian winters and northern environments.

The objective of this project is to undertake the conceptual design of a prototype Canadian railbus. The design will be based on a standard, Canadian-made highway bus. The vehicle must accommodate at least 40 passengers and their baggage, and have a minimum cruising speed of 100 km/h on tangent track. It must be operable by one person and capable of reversing direction.

The Canadian railbus design will provide a reference base for decisions regarding railbus service in Canada.

Progress to June 1986

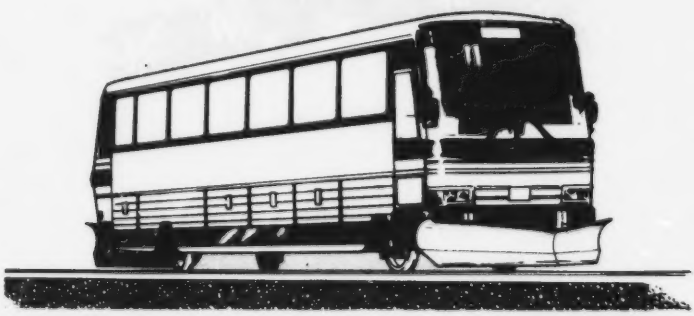
The preliminary design and specifications of the vehicle have been completed. A technical report is being prepared.

Contractor

Transportation Technology Ltd., Kingston, Ontario

Report

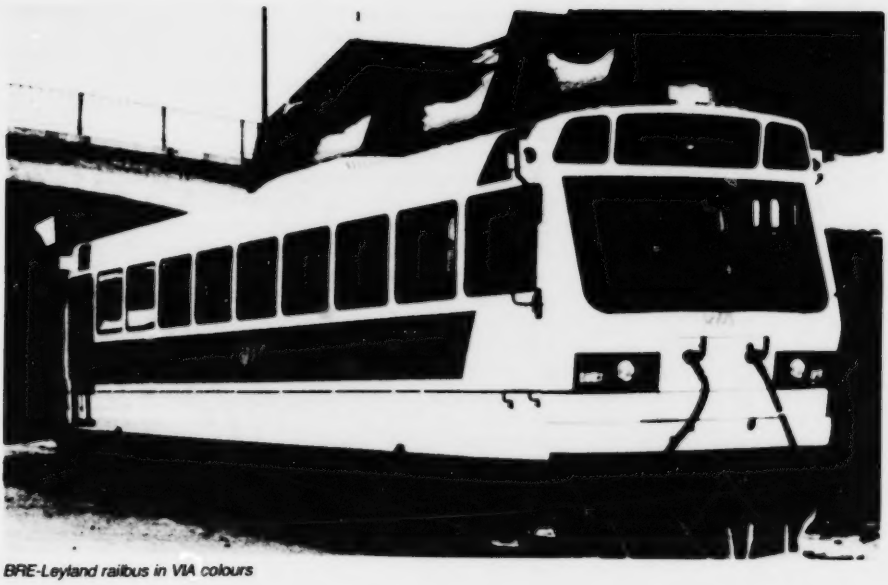
None to date



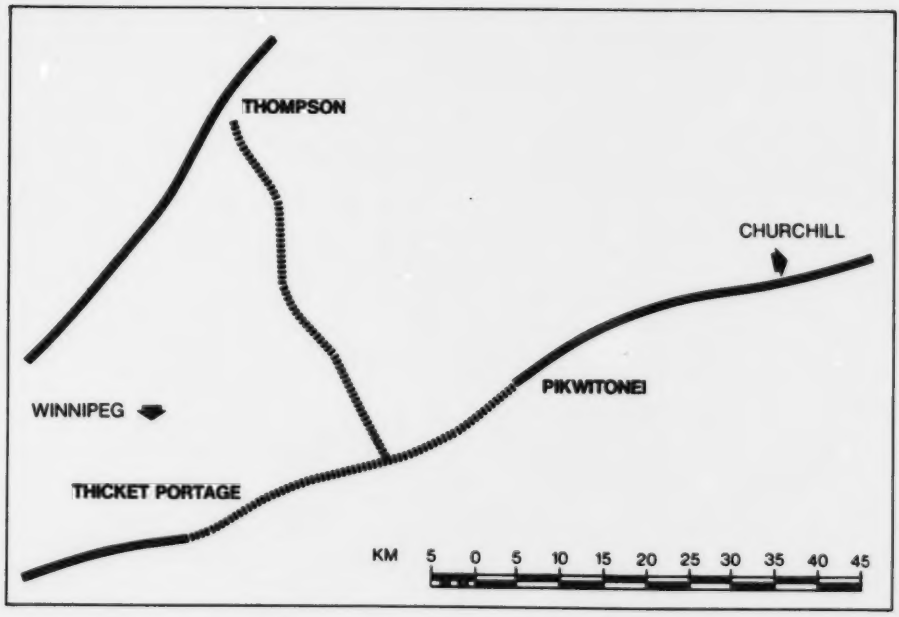
Artist's drawing of Canadian advanced-design railbus

Schedule: January 1986 — March 1987
Funding: DSS — $270,000

Project Number: 6558
File Number: D 1465-425-7
Project Officer: Sesto Vespa



BRE-Leyland railbus in VIA colours



BRE-Leyland Railbus Evaluation and Demonstration

Description

One element of the railbus development and demonstration program being undertaken by TDC on behalf of Transport Canada's Rail Passenger Directorate involves testing and evaluating applicable foreign rail technologies in passenger service under Canadian conditions. TDC has identified the British BRE-Leyland light diesel railbus as a suitable candidate for evaluation. The vehicle underwent an intensive development and testing program — including demonstration service in Europe, Southeast Asia and the United States — before British Rail introduced it into revenue service.

TDC negotiated an agreement with BRE-Leyland to bring its model 141 railbus to Canada for testing in a multi-phase evaluation program consisting of:

- off-road acceptance and safety testing,
- road and technical testing,
- demonstration to interested operators, and
- non-revenue passenger demonstration service.

Progress to June 1986

The first phases have been completed. Road and technical tests were conducted by the National Research Council and VIA Rail on CN track in the Lac St. Jean region. These tests included curving performance in the loaded condition, and tangent track stability in both loaded and unloaded states. Stability, acceleration and braking tests were performed over a six-kilometre stretch of indifferent track at speeds of up to 79 km/h. All signals were appropriately activated by the railbus when tested at speeds up to 96 km/h. No problems were found with the vehicle.

The testing also concluded that the shunting capability of the railbus compares favourably with that of a single-unit rail diesel car. However, the single-unit railbus does present difficulties to the wayside hot-box detector reporting systems. Development of an on-board hot-box detection system was recommended.

CN Rail and the Canadian Transport Commission have approved the non-revenue passenger demonstration service. A two-month service has begun on the Thompson-Pikwitonei-Thicket Portage line in Manitoba.

Contractors

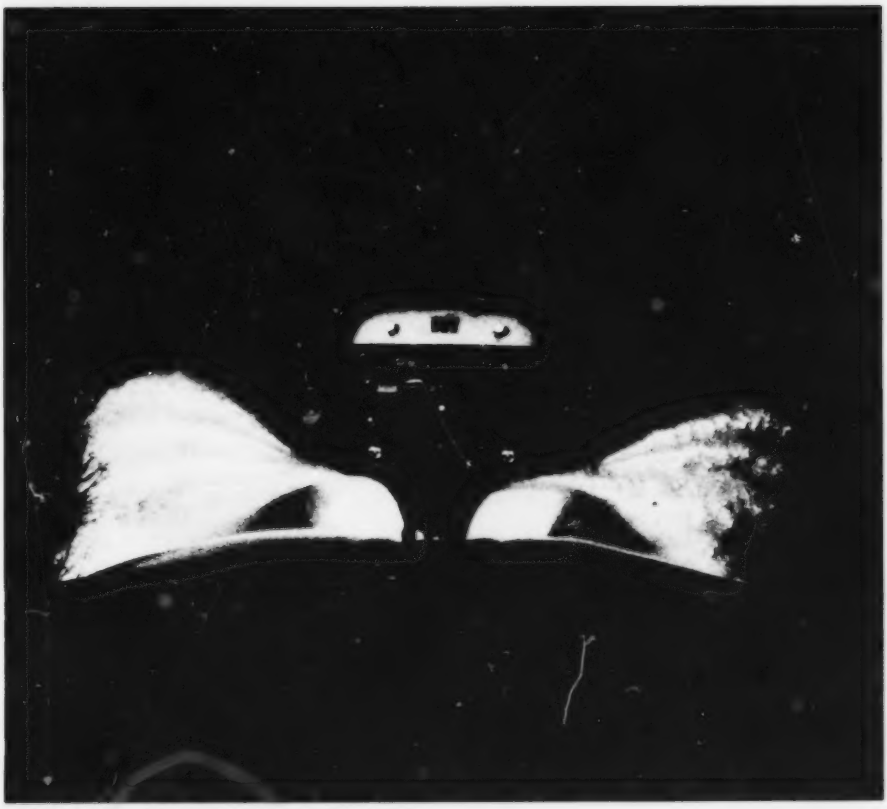
National Research Council, Ottawa, Ontario
VIA Rail Canada Inc., Montreal, Quebec
British Rail Engineering Ltd., Derby, England

Report

None to date

Schedule: December 1985 — September 1986
Funding: TDC — $311,600

Project Number: 6642
File Number: D 1465-425-9
Project Officer: Sesto Vespa



WCSS railbus in winter tests

Testing of WCSS Railbus

Description

In 1984-85, TDC supported the conversion and testing of a Western Flyer motor coach modified for rail operation to investigate the technical and operational issues involved in railbus operation.

Winnipeg Coach Sales and Services Ltd. (WCSS) converted the motor coach, equipping it with steel wheels and modifying the suspension, brakes, drive train and lights. A hydraulic turntable was installed to allow the railbus to reverse direction. WCSS successfully conducted preliminary operational tests of the vehicle on the tracks of the Greater Winnipeg Water District Railway.

The current testing program consists of three phases: first, a program of intensive technical tests; second, non-passenger tests under winter conditions; and, third, a non-revenue passenger demonstration.

The results of this testing program will provide technical and operational experience and data to resolve regulatory and institutional issues concerning railbus passenger operation.

Progress to June 1986

The railbus accumulated 3,347 km of operation during the intensive tests, which evaluated stability, curving, switching, braking and operation of various auxiliary systems. These tests were conducted on the Inco Pipe Mines Railway line in Thompson, Manitoba. No major problems were identified. Ride quality was judged to be satisfactory. The interior noise level was reduced during the evaluations by various modifications. The vehicle proved to be capable of sustained, safe operation at speeds up to 90 km/h.

Based on the results of the tests, CN and the Canadian Transport Commission approved the railbus for non-passenger operational tests, which were conducted in winter on the CN Thompson-Pikwitonei-Thicket Portage railway line in Manitoba. The vehicle required modifications to improve reliability and cold weather operations.

CN and the Canadian Transport Commission have approved demonstration passenger operations on the same line. The non-revenue experimental service began in June 1986.

Contractor

Transportation Technology Ltd., Kingston, Ontario

Reports

TP 7414E, Testing of the WCSS railbus on the Inco railway line, Transportation Technology Ltd., 1985.
TP 7130E, Plan for the testing of the WCSS railbus on the Inco railway line, Transportation Technology Ltd., 1985.

Schedule: September 1985 — July 1986
Funding: TDC — $397,246

Project Numbers: 6518, 7597
File Numbers: D 1465-425-6/12
Project Officer: Sesto Vespa

Rail Passenger Vehicle for Remote Services

Description

VIA Rail Canada Inc. operates a number of services on lines with low to marginal traffic densities. Some of these routes serve remote areas in Canada's north where there are few roads, air service is limited and weather conditions restrict both road and air operations for much of the year. Many small northern communities depend almost entirely on rail service for access to the outside world and for supplies, mail and other necessities. These remote rail services exist by virtue of social necessity. The low cost-recovery target set for VIA by the Minister of Transport on some of these routes recognizes that reality.

Conventional rail technology is costly to procure and operate, hence VIA is encouraged to seek the most cost-effective means by which to provide remote rail services.

The objective of this project was to develop one or more conceptual designs for a technologically superior, economically attractive alternative to existing equipment for remote area passenger service in Canada.

Progress to June 1986

The project is complete. The costs of providing VIA's remote rail passenger services were reviewed in relation to revenue and in the general context of VIA's overall economy.

The report puts forward a number of remote service vehicle designs as possible replacements for VIA's aging fleet of rail diesel cars now in service, and as alternatives to the locomotive hauled train service provided by the national railways to VIA at a cost.

The vehicles considered include the BRE-Leyland and Ganz-Mavag/ Ikarus railbuses, the Wickham Rail Car and a concept for a heavy-duty vehicle combining the features of a locomotive, passenger car and snowplow.

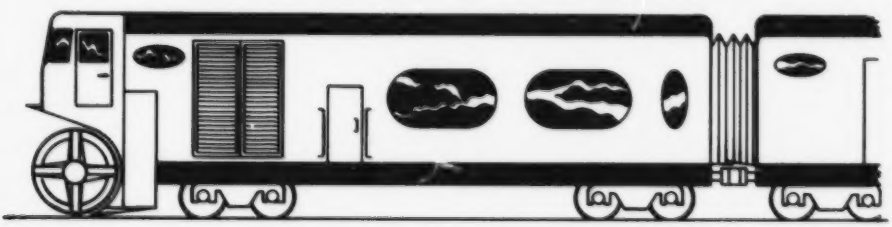
The merits of the various vehicle designs are discussed from the point of view of reliability, quality of service and, to a limited extent, cost.

Contractor

Queen's University, Canadian Institute of Guided Ground Transport, Kingston, Ontario

Report

TP 6112E, Rail passenger vehicle for remote services, Queen's University, Canadian Institute of Guided Ground Transport, 1986.



Artist's sketch of a remote service rail vehicle with a rotary snowplow

Schedule: September 1983 — May 1986

Funding: TDC —	$30,900
VIA Rail —	$15,000
Total —	$45,900

Project Number: 6055
File Number: D 1465-423
Project Officer: Brian Marshall

SURFACE TECHNOLOGY

Surface Technology

TDC's surface transportation technology program addresses several vehicle types: trucks, buses, electric and off-road vehicles, light rail transit cars, magnetically levitated vehicles, pipelines, etc.

TDC's research projects in this area are grouped under these six main headings:

- highway transportation
- urban transportation
- transportation for the elderly and the disabled
- tracked, levitated vehicles
- off-road and solids pipeline
- multimodal transportation

Highway Transportation

In Canada, most goods and people travel by highway. The highway system is the backbone of the country, and maintenance of the entire system has created demanding technical problems. Improved productivity for commercial users of the highway system will benefit both the national economy and individual Canadians. Yet, Canada's highway system is predominantly a provincial responsibility with many private sector firms and the general public as users. Accordingly, the bulk of TDC's highway research program is jointly undertaken with the provinces and industry.

A project to develop uniform regulations governing weights and dimensions for interprovincial trucking will help to improve the safety and productivity of Canadian trucking operations. Other trucking projects are aimed at improving ride quality, vehicle stability and fuel efficiency. Novel trailer configurations and auxiliary systems are also under study. Research on intercity bus transportation continues, with projects aimed at improving bus air quality and suspension systems. A pilot demonstration program of an articulated bus is also underway.

Urban Transportation

Although urban transportation is a municipal and provincial concern, TDC is supporting projects in this field which contribute to federal government objectives such as energy efficiency and safety. In the area of energy conservation, projects include: making propane an attractive fuel option for road vehicles; developing batteries for electric vehicles; and applying microprocessor technology to traffic management systems.

Transportation for the Elderly and the Disabled

Transport Canada is committed to seeking ways to remove transportation barriers that limit or restrict the mobility of disabled Canadians. To this end, TDC is fostering the development of equipment, systems and procedures that permit all Canadians equal access to the nation's transportation systems. Projects include: developing accessible vehicles; studying traffic regulations for motorized mobility aids; developing communication aids for use in transportation terminals; studying ways of providing wheelchair passengers access to trains and buses; and optimizing the efficiency of special transit services through computerized scheduling and dispatching.

Tracked, Levitated Vehicles

Tracked, magnetically levitated (Maglev) vehicle technology is being studied as a possible future transportation system for intercity travel. Maglev systems promise safe, fast and efficient operations with minimal environmental impact.

Off-Road and Solids Pipeline

TDC's aim in off-road transportation is to develop alternative means of transporting people and goods. The research is varied: slurry pipelines offer efficient transportation for bulk commodities such as coal; rugged snowmobiles are being tested to carry people and goods in northern regions; and an innovative vehicle, the Aerobac, is being evaluated.

Multimodal Transportation

Projects in this area address technological and system developments that are applicable to more than one mode. Current projects include developing computer simulation programs for use in managing ports and grain terminals.

Testing of Acoustic Emissions of Compressed Gas

Description

The transport of dangerous goods is rigorously controlled on Canadian highways. The trailers used to transport industrial gases in compressed form must be inspected visually every two or three years, and hydrostatically every five years. These tests involve disassembly of the trailer and cost approximately $30,000 per vehicle.

Researchers have proposed a new test method that uses acoustic emission technology in lieu of hydrostatic testing. The proposed method has the potential to provide better testing at lower cost. The acoustic emission test would not require trailer disassembly, and the trailer could be pressurized with an actual product, reducing the risk of tank contamination. The test would locate a defect by resolving signal travel time equations. A follow-up ultrasonic test would then determine the nature of the defect and document it for reference during future tests.

The objectives of this project are to develop and test a compressed-gas container testing method using acoustic emission technology, and to obtain regulatory approval of the testing method. Once the test is developed, a one-year monitoring program will conduct parallel hydrostatic and acoustic emission tests on five designated vehicles. The results of the monitoring will be compared and evaluated.

Progress to June 1986

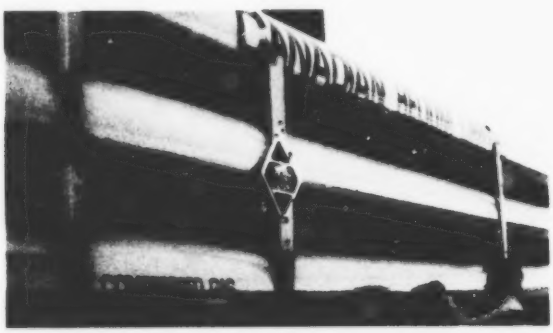
Investigators are testing cylinders with known flaws, using both the acoustic emission test and the hydrostatic test. The results of this testing will provide a direct comparison of the effectiveness of the two test methods.

Contractor

Tektrend International Inc., Montreal, Quebec

Report

None to date



A modern tube trailer used to transport compressed gases. At present, these trailers require costly disassembly for hydrostatic testing every five years.

Schedule: August 1985 — August 1987

Funding: DSS —	$ 60,000
Hydrogen Council —	$ 5,000
DGRD —	$ 5,000
EMR —	$ 15,000
NRC —	$ 15,000
Total —	$100,000

Project Number: 6488
File Number: D 1465-461
Project Officer: Lewis Sabounghi

Tilt table in operation at Transport Canada's Motor Vehicle Test Centre

Vehicle Weights and Dimensions Program: Static Testing

Description

The efficiency of trucking in Canada is seriously hampered by wide variations in provincial trucking regulations. The lack of uniform regulations for vehicle weights and dimensions is particularly troublesome. Western Canada, for example, permits longer trucks on its roads than eastern Canada. At the same time, trucks can carry heavier loads in the East than in the West. As a result, interprovincial carriers must operate at the lowest common length and weight limit in all provinces.

The overall objective of this extensive research program is to develop the criteria for uniform weight and dimension regulations for trucks throughout Canada. To accomplish this task, researchers are studying (1) the stability and control of trucks currently operating in Canada; and, (2) pavement response to heavy vehicles.

In the first study, computer simulations are being used to evaluate the effect of such factors as gross weight, axle weight, suspension type and tire type on a number of truck configurations. Extensive field tests corroborate the results of the computer simulations. A special tilt table has been built to measure static rollover.

The pavement study will evaluate the impact of different axle and wheel load combinations on 15 instrumented test pavements across Canada. The forces imposed on the road by various suspension systems will also be measured in a dynamics laboratory.

The results of this program will assist vehicle designers and highway regulators, and will permit truck owners to optimize their fleet operations.

Progress to June 1986

The tilt table was constructed and installed at Transport Canada's Motor Vehicle Test Centre in Blainville, Quebec, in the fall of 1985. Field tests and tilt table tests have been satisfactorily completed. The computer simulation is in the final stages and the analyses and reports are being prepared.

Contractors

Canroad Transportation Research Corporation, Ottawa, Ontario
Centre de recherche industrielle du Québec, Ste-Foy, Quebec

Report

None to date

Schedule: September 1984 — September 1987
Funding: TDC — $755,803

Project Numbers: 6175, 6287
File Number: D 1465-421
Project Officer: Lewis Sabounghi

Vehicle Weights and Dimensions Program: Impact Analysis

Description

TDC is supporting technical studies to determine the impact of large trucks on road surfaces and highway safety. The findings of this work may affect the way in which provincial and territorial governments regulate truck size and weight. Regulations have changed significantly over the past decade, but little research has been undertaken to analyze the potential benefits of these changes to the trucking industry. The objective of this project is to analyze the impact of current regulations on trucking operators.

Researchers will gather regulatory information and interview carriers and shippers. They will then analyze the data to see how regulations affect truck fleet operations and what effect standardization would have on the industry.

This project complements other technical studies. Together, the results will be used to reach national standards for vehicle weights and dimensions.

Progress to June 1986

Researchers analyzed weight and dimension regulations of each province and territory, reviewed the literature in this field and surveyed available provincial licensing data to assess its adequacy for analysis. Background papers have been prepared.

Contractor

University of Toronto, Toronto, Ontario

Report

None to date

Schedule: April 1985 — September 1986

Funding: DGRD —	$125,000
ADMS —	$ 25,000
Total —	$150,000

Project Number: 6374
File Number: D 1465-421-3
Project Officer: Lewis Sabounghi

Truck Seat Vibration Study

Description

The constant vibration of heavy trucks is believed to be a cause of some physical ailments experienced by drivers, including many lower back pains. Changing the design of truck seats may reduce the amount of vibration felt by drivers.

Before modifications to seat designs can be recommended, the amount of vibration transmitted from the cabin floor, through the seat, and to the driver must be measured.

The objective of this project is to develop and calibrate a computer model to simulate various seat suspension systems. The model will be used to analyze the vibration transmission patterns of the most common truck seats currently in use in Canada. The model will be calibrated in the laboratory using truck seats supplied by manufacturers.

A subsequent project will measure vibration levels in the field and, using the results of the computer model and the field test, develop new seat suspensions.

Progress to June 1986

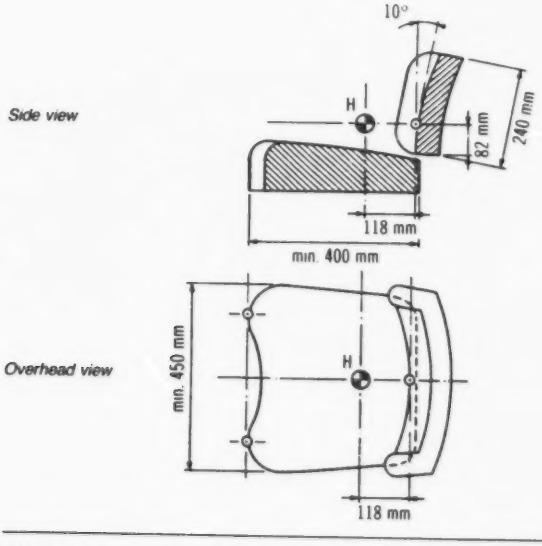
Researchers have detailed the factors influencing the vibration environment of a heavy truck. These factors include highway profile, tires, cargo, suspension at the wheels, rigid body modes of the vehicle, driver location, geometric peculiarities of articulated trucks, etc. Modelling is underway.

Contractor

Concordia University, Montreal, Quebec

Report

None to date



Side view

Overhead view

Recommended geometry for truck seats

Schedule: September 1984 — October 1986
Funding: TDC — $93,920

Project Number: 6330
File Number: D 1590-1
Project Officer: Lewis Sabounghi

Liquid Tanker Stability Research

Description

Larger liquid tanker trucks are appearing on Canadian highways at the same time as regulations controlling the transport of dangerous goods are being strengthened. It is therefore important to understand the effect larger tanker configurations have on truck stability. Trucks are least stable when their tanks are only partially full because the liquid sloshes inside the tank.

The objective of this project is to develop a computer model to simulate the dynamic stability of a liquid tanker truck. The model will be used to evaluate various tank and baffle shapes currently being used to reduce sloshing.

The findings of these evaluations will be used to develop design standards for anti-sloshing devices and a method of testing the stability of liquid tanker trucks.

This project will build on the knowledge acquired in the vehicle weights and dimensions study.

Progress to June 1986

Literature searches and field surveys have been conducted to determine the characteristics of liquid tankers currently on Canadian highways. A computer model has been developed to analyze the static roll behaviour of partially loaded tankers.

Contractor

Seshadri Sankar Inc., Brossard, Quebec

Report

None to date

Schedule: June 1985 — December 1987
Funding: EMR-Energy R&D Program — $225,000

Project Number: 6407
File Number: D 1465-421-4
Project Officer: Lewis Sabounghi

Carbon Dioxide Refrigeration System for Trucks

Description

Trucks carry 85 per cent of the nearly 10.5 million metric tonnes of perishable foods transported in Canada each year. These foods must be refrigerated during transport. Breakdown of compressors and other mechanical components of truck refrigeration systems often results in spoilage.

Carbon dioxide (CO_2) cryogenic refrigeration, which does not rely on moving parts, is considered more reliable than the mechanical refrigerators currently used on trucks. However, no CO_2 system has been designed specifically for truck use.

This project has three objectives: to develop, test and demonstrate a CO_2 refrigeration system suitable for long-haul trucks; to evaluate the effectiveness of the system; and, to define a CO_2 distribution network to serve trucks in Canada.

The contractor developed and tested adaptations of two existing CO_2 refrigeration systems. One is a "coolspray" system, which injects CO_2 snow into the cargo space on a demand basis to maintain the required temperature. The other is a "coldsink" system, which varies CO_2 pressure in a closed system to attain the required temperature.

Progress to June 1986

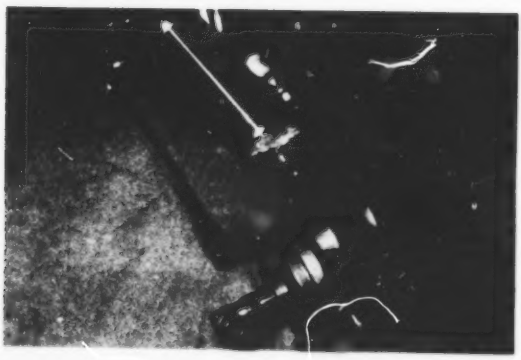
A detailed market and technology assessment is underway.

Contractors

Fridev Refrigeration Systems Inc., Brossard, Quebec
Concool Refrigeration Ltd., Pointe-Claire, Quebec

Report

None to date



Carbon dioxide injector nozzle used in coolspray system

Schedule: November 1985 — May 1988

Funding: TDC —	$ 60,000
DSS —	$ 40,000
EMR-Energy R&D Program —	$259,500
Agriculture Canada —	$ 50,000
Total —	$409,500

Project Number: 6495
File Number: D 1465-455
Project Officer: Lewis Sabounghi

Synthetic Lubricant Test Program

Description

Synthetic lubricants have superior thermal and chemical stability and lower friction coefficients than conventional mineral-oil lubricants. However, synthetic lubricants cost three to five times more than conventional lubricants.

The objective of this project is to test and demonstrate the fuel economies that may be realized through the use of synthetic lubricants in road vehicle engines and drive trains. If these economies are proven to be substantial, truck fleet owners may find it attractive to switch to synthetic lubricants.

Initial testing will be carried out on heavy tractor models equipped with Cummins diesel engines. The test procedures developed will then be applied to other commercial vehicles provided by manufacturers.

Progress to June 1986

Two matched vehicles — one using mineral-oil lubricants, the other using synthetic lubricants — were performance-tested at Transport Canada's Motor Vehicle Test Centre in Blainville, Quebec, under winter conditions. The results of these tests are being analyzed.

Contractor

Domex Inc., Montreal, Quebec

Report

None to date

Schedule: November 1985 — September 1986
Funding: EMR-Energy R&D Program — $194,005

Project Number: 6572
File Number: D 1465-468
Project Officer: Lewis Sabounghi

Heavy Vehicle Fuel Consumption Research

Description

The fuel consumption rate of heavy road vehicles is affected not only by the vehicle parameters but also by driving techniques, road surfaces, road geometry and the characteristics of a vehicle's undercarriage. The effects of vehicle parameters on fuel consumption are well documented, but little is known about the effects of the other factors. As well, no model is available to analyze the impact of one factor on another.

Forest Engineering Research Institute of Canada, Pointe-Claire, Quebec, has developed — as part of its long-term research program into road transportation — a sophisticated system of obtaining and quantifying data on fuel consumption factors. The system collects data from purpose-built field instruments.

The objective of this project is to support the contractor's efforts to quantify factors known to affect fuel consumption. The data obtained from extensive field tests involving the contractor's research system will be used to program cross-reference impact analyses of factors shown to affect fuel consumption.

Two video productions will be made for use by industry for driver training. One will illustrate the impact of road surface, road geometry and driving techniques on fuel consumption; the other will illustrate the impact of vehicle components.

Progress to June 1986

The instrumentation of vehicles for the field tests is complete. Preliminary tests are being run.

Contractor

Forest Engineering Research Institute of Canada, Pointe-Claire, Quebec

Report

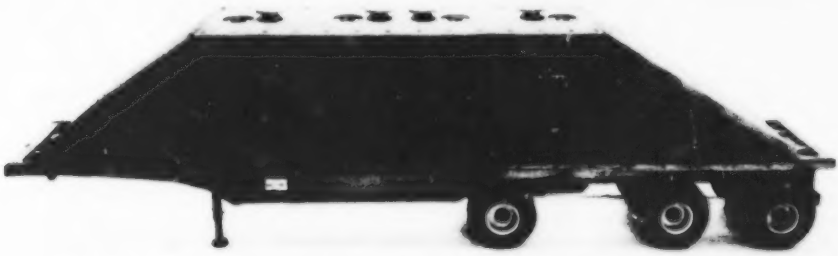
None to date

Schedule: December 1985 — March 1987

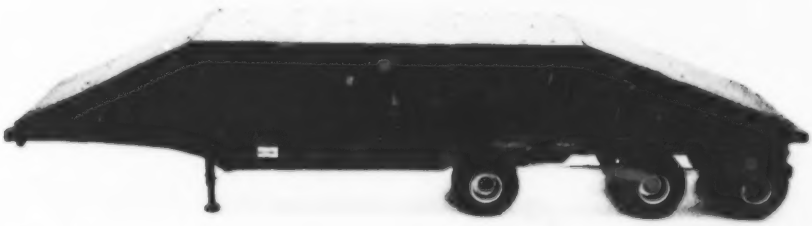
Funding: TDC —	$ 5,000
EMR-Energy R&D Program —	$275,000
Total —	$280,000

Project Number: 6593
File Number: D 1465-470
Project Officer: Lewis Sabounghi

Chameleon as dry bulk carrier, fully loaded, in hopper configuration



Chameleon as dry bulk carrier ready for loading



Conversion in progress

Chameleon in flatbed configuration, ready for loading

Convertible Flatbed/Dry Bulk Trailer

Description

Bulk carriers are currently designed as single-purpose units. They carry specific products such as grain, sugar and cement from source to market, then frequently return empty. D. Neumann & Associates, of Pointe-Claire, Quebec, has developed a concept for a truck trailer that can be easily converted from a bulk carrier to a flatbed, thereby enabling it to be used for more than one purpose. The concept, which features a flexible container system made of a fabric developed by Hoechst and Bayer, would permit trucks to carry a regular payload on their return trips, thus reducing operating costs.

TDC supported a viability study of the concept, which concluded that it has a competitive edge over existing equipment because of its operating flexibility and lower construction and operating costs. Potential markets for the trailer were also identified.

The objective of this project is to develop a commercial prototype of the flatbed/dry bulk trailer combination to be used for testing and demonstrations.

Progress to June 1986

The prototype trailer has been constructed. A driver is able to convert the vehicle from a dry bulk carrier to a flatbed (or vice/versa) in minutes. The flexible, high-strength cargo container is pneumatically inflated and supported by an extendable steel frame that locks rigidly into position. Road testing of the trailer, known as the Chameleon BULKTRAILER, will begin in mid-summer 1986.

Contractor

D. Neumann & Associates, Pointe-Claire, Quebec

Report

None to date

Schedule: March 1985 — July 1986

Funding: DSS —	$150,000	**Project Number:** 6383
EMR-Energy R&D Program —	$ 58,000	**File Number:** D 1465-440-3
Total —	$208,000	**Project Officer:** Lewis Sabounghi

Costing Methods for Trucking Operations

Description

In order to conduct a profitable business in an intensely competitive market, trucking companies must know of the actual costs of their various services. This need will become acute if the industry is deregulated and companies are required to set their own rates. To assist the industry with this complex problem, Transports Québec, the Bureau des tarifs du Québec, the provincial trucking association and TDC are developing a costing method for Canadian trucking operations.

The first phase of the project, completed in 1985, developed a costing method for pick-up and delivery operations. The method is applicable to all types of carriers and goods and uses real field data rather than standard or average times. The method was successfully validated using data from six different trucking companies.

The second phase of the project will develop a costing method for docking and handling operations at terminals and for line transportation costs. This study will complement the method developed in phase one.

The results of this work will help trucking companies improve their operations management by giving them information about vehicle selection, territory segmentation, and inefficiencies related to geographical areas, clients or type of freight.

Progress to June 1986

The second phase has just started.

Contractor

Association du camionnage du Québec Inc., Montreal, Quebec

Report

None to date

Schedule: March 1986 — December 1986
Funding: TDC — $62,000

Project Number: 6666
File Number: D 1465-450-2
Project Officer: Lewis Sabounghi

Quality of Air in Buses: A Study

Description

Although air quality inside buses is an important factor in passenger comfort and satisfaction, manufacturers have not conducted in-depth studies on the subject in recent years. Second-hand smoke and body odour are the major subjects of complaint from passengers.

In 1985, TDC supported a project to assess the quality of air in buses. The study recommended increasing the volume of fresh air in ventilation systems and adding electrostatic filters with dust collection capability to ventilation systems.

The objective of this project is to study air cleanliness and distribution in conventional buses.

The contractor will: develop an air circulation model describing the interior aerodynamics of the vehicle; study the amount of smoke given off by smoking passengers and in the ambient air; and, analyze the physical characteristics of particles found in the air. The results of this research will lead to specific recommendations for ventilation and filtration systems to improve passenger comfort.

Progress to June 1986

Work on this project has just started.

Contractor

De Leuw Cather Canada Ltd., Ottawa, Ontario

Report

None to date

Schedule: June 1985 — April 1986

Funding: TDC —	$ 5,000
EMR-Energy R&D Program —	$75,000
Total —	$80,000

Project Number: 6616
File Number: D 1465-428
Project Officer: Catherine Hirou

Prévost H5-60 articulated bus

Articulated Bus Demonstration

Description

In 1979 TDC supported Voyageur Inc. in a technical, operational and economic assessment of the feasibility of using articulated buses in Canada. Based on the findings of the study and on information from European manufacturers, a German-made Neoplan bus was selected for testing on one Voyageur route. The bus was found to be unsuited to the Canadian environment. Prévost Car Inc. of Ste-Claire, Quebec, then began developing an articulated bus with the assistance of the federal and Quebec governments. A prototype of the technically advanced Prévost H5-60 has been completed.

Transport Canada and Transports Québec want to promote production and development of the articulated bus, which could help the economic viability of intercity bus transportation, while offering improved passenger comfort. Funds have been allocated under the Canada-Quebec Economic Regional Development Agreement for a major program of operational demonstrations using 24 of the new Prévost articulated buses.

This project is the first phase in a proposed comprehensive demonstration program that will culminate in a two-year service demonstration of the Prévost bus on Voyageur's Montreal-Quebec route. The prototype will first be tested for reliability and suitability to Voyageur's requirements. A two-month endurance test will log 65,000 km over Voyageur's various routes. In addition, the ability of the bus to manoeuvre in garages, terminals, maintenance facilities and parking lots will be confirmed, and technical tests will be performed on specific components and subsystems of the vehicle. If all goes well with the prototype testing, Voyageur is expected to order 20 buses for the two-year service demonstration.

Progress to June 1986

The endurance test has been completed. The results of technical evaluations to date have been positive.

Contractor

Voyageur Inc., Montreal, Quebec

Report

None to date

Schedule: March 1986 — March 1987

Funding: TDC —	$ 50,863
Transports Québec —	$ 50,863
Total —	$101,726

Project Number: 6728
File Number: D 1465-490-3
Project Officer: Brian Marshall

Advanced Bus Suspension Program

Description

Buses are the most economical and fuel-efficient method of intercity transportation. Bus operators regard the limitations of existing suspension systems as the major obstacle to improving passenger comfort, and therefore to attracting more passengers. Suspension system design also affects, directly or indirectly: structural weight, vehicle performance, manoeuvrability, capital cost, operating and maintenance costs and road surface wear. However, no mathematical model has been developed to assist designers in evaluating new suspension systems for buses.

The objective of this project is to develop such a model and to use it to identify the most promising suspension technology for Canadian buses, from both a technical and economic viewpoint. The model will evaluate air, hydraulic, rubber and steel suspension systems, and be validated by road-testing a conventional highway bus in various configurations.

Progress to June 1986

A state-of-the-art review of highway bus suspension technology has been completed. The general characteristics of present-day systems have been summarized and the performance requirements of an advanced system specified.

Contractor

Transportation Technology Ltd., Kingston, Ontario

Report

None to date

Schedule: November 1985 — September 1986

Funding: TDC —	$ 38,000
EMR-Energy R&D Program —	$200,000
DSS —	$100,000
Total —	$338,000

Project Number: 6499
File Number: D 1465-457
Project Officer: Brian Marshall

Incrementally Variable Transmission Dynamics

Description

Ker-Train Systems Ltd. of Kingston, Ontario, has developed a unique, incrementally variable transmission (IVT) for use in electric vehicles. It features a 64-step transmission with regenerative capability, a maximum torque output of 574 N·m at 166 rpm, a microprocessor control system and an overall efficiency of 95 per cent. The IVT was installed in a Marathon C-360 electric van and successfully demonstrated over a two-year period. Almost 1,000 hours of operation have been logged in road and bench tests.

The objective of this project was to evaluate the IVT's torque and efficiency during gear changes under load. Input and output torques were electronically monitored during gear changes. Transient torques were minimized by adjusting the timing of the engagement and disengagement of clutches.

Previous studies of the Ker-Train IVT have all confirmed the potential of the design for use either in electric vehicles or with internal combustion engines under steady load conditions. The results of this project provided important new knowledge about the transient dynamics of gear changing.

Progress to June 1986

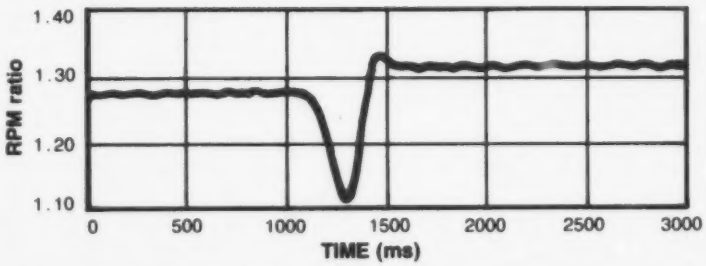
The data gathering is complete. Preliminary analysis indicates that by properly adjusting each element of the gear change, transients can be kept to within 30 per cent, a range acceptable to the application.

Contractor

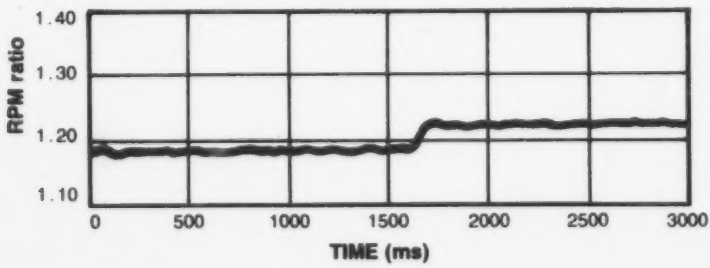
Royal Military College, Kingston, Ontario

Report

None to date



Graph showing untimed gear shift. Gear ratio does not change smoothly from 1.272 rpm to 1.310 rpm.



Graph showing timed shift. The disturbance essentially disappears.

Schedule: September 1985 — June 1986
Funding: TDC — $13,500

Project Number: 6570
File Number: D 1465-385-4
Project Officer: John H. Morgan

Incrementally Variable Transmission for Urban Buses

Description

Four-stroke engines are more fuel efficient than two-stroke engines. To take advantage of this fact, many urban buses have been converted from two-stroke to four-stroke. However, four-stroke engines take up more space, which means retrofitted buses often have to use smaller, less powerful four-stroke engines. To prevent performance degradation, all available torque from the four-stroke engines must be transmitted to the wheels.

The objective of this project is to investigate the feasibility of using an incrementally variable transmission (IVT) in urban buses powered by four-stroke engines. The IVT was developed by Ker-Train Systems Ltd. of Kingston, Ontario, for use in electric vehicles.

Progress to June 1986

Researchers developed a design definition, specification layout and preliminary design for installation in a bus. Both a 64-step and a 16-step IVT were considered. The IVT's potential efficiency for urban bus service was analyzed using three different simulated case studies:

- a base case, in which the transmission was programmed to minimum fuel consumption;
- an emission case, which minimized emission of solid pollutants; and,
- a regeneration case, which assumed pneumatic, hydraulic and/or flywheel energy storage or braking.

The report concluded that as the number of ratio states of a transmission is increased, the torque convertor may be eliminated and an overall fuel saving of at least 20 to 30 per cent may be attained; the 64-step transmission can be programmed to minimize particulate emissions; and, the incorporation of mechanical or hydraulic brake-energy recovery mechanisms does not appear to be cost-effective.

Contractor

Linamar Machine Ltd., Guelph, Ontario

Report

TP 7224E, Incrementally variable transmissions for urban bus, Linamar Machine Ltd. and Ker-Train Systems Ltd., 1986.

Schedule: August 1984 — May 1986

Funding: TDC —	$ 80,000
EMR-Energy R&D Program —	$ 30,000
Other —	$ 61,000
Total —	$171,000

Project Number: 6263
File Number: D 1465-441
Project Officer: John H. Morgan

Propane in Diesel Engine Cylinders

Description

One of the objectives of Canada's energy policy is to substitute propane for petroleum-based fuels. Virtually all heavy-duty vehicles and an increasing number of medium-duty vehicles currently use diesel fuel.

The objective of this project is to develop efficient and reliable ways of modifying diesel engines to run either partly or completely on propane.

SNC Inc., of Montreal, is studying a direct injection technique that uses a small quantity of diesel fuel to ensure effective combustion of the propane. This approach offers 85 per cent propane displacement of the engine's diesel fuel consumption. The only modification required to the engine is replacement of the normal fuel injector with a dual-fuel injector. Once the design has been proven, a market assessment of the equipment will be made.

Progress to June 1986

SNC Inc. designed, fabricated and bench-tested a dual-fuel injector. Further tests conducted at the University of Toronto included reference tests on an inlet manifold fumigation system to establish a performance baseline, development of a prototype dual-fuel injector and dual-fuel injection testing on a laboratory single-cylinder engine. Initial results suggest up to 70 per cent displacement of diesel fuel by propane is practical, with significant reduction in smoke and hydrocarbon emissions. The report concluded that development potential exists for operation of the concept with a wide range of non-diesel fuels or synthetic fuels.

Contractor

SNC Inc., Montreal, Quebec

Subcontractor

University of Toronto, Toronto, Ontario

Report

Draft, Propane/diesel injection system for diesel truck engines, SNC Inc.

Schedule: March 1984 — June 1986
Funding: EMR-Energy R&D Program — $249,700

Project Number: 6118
File Number: D 1465-434
Project Officer: John H. Morgan

Improved Propane Refuelling for Road Vehicles

Description

TDC has supported the development of technology for using propane as a substitute for gasoline or diesel fuel in road vehicles. This technology is now well developed, yet there remain several obstacles to widespread use of propane. Ease of refuelling is one problem. The present refuelling process is awkward, has no standard interface between the dispenser and the vehicle, and is difficult to incorporate into self-service operations. Several provinces require trained, licensed attendants to dispense propane. A simple refuelling system would make propane more attractive to consumers and encourage vehicle conversions.

The objective of this project is to develop a safe and simple system of dispensing propane to road vehicles. The system must be compact, and have a reliable, 80 per cent fill-limiting device that does not depend on the emission of propane vapour or liquid.

Progress to June 1986

The project is complete. A design definition and specification has been completed. The design features a lightweight, easily operated spout and several concepts for fill limiting.

Contractor

DSMA ATCON Ltd., Toronto, Ontario

Report

TP 7151E, Improved refuelling techniques for propane vehicles, Phase I, DSMA ATCON Ltd., May 1986.

Schedule: November 1984 — May 1986
Funding: EMR-Energy R&D Program — $64,884

Project Number: 6187
File Number: D 1465-439
Project Officer: John H. Morgan

Aluminum/Air Battery for Vehicles

Description

Advancements in electric vehicle technology could reduce Canada's dependence on petroleum-based fuels. Researchers are focussing on finding a substitute for the common lead-acid battery. New battery technology must offer increased vehicle range through increased energy density, while retaining the low cost and easy starting characteristics of conventional batteries.

This project is intended to develop a hybrid power supply for electric vehicles. The power supply combines a saline electrolyte, aluminum/air cell with conventional lead-acid batteries.

Low weight is the most attractive feature of the aluminum/air cell: it has an energy density of 200 Wh/kg, compared with 40 Wh/kg for the best lead-acid battery. However, current aluminum/air cells have a low power output. The hybrid power supply uses the best characteristics of both types of batteries: the conventional batteries supply power during heavy demand, while the aluminum/air cells provide increased range with a minimum increase in onboard weight.

Researchers will build and test a vehicle powered by a 36-V DC hybrid battery system. Results will be used to develop a 96-V DC system for full-size electric vehicles.

The current target for battery performance for a delivery van is a storage capacity of 20 to 30 kW, a maximum power of 30 kW and an average power of 10 kW.

Progress to June 1986

Researchers determined that the aluminum/air battery can tolerate temperatures down to -20°C and that commercial grade aluminum can be utilized. The design allows for management of heat and hydrogen liberated from the battery. Testing of single cells shows power densities of 20 W/kg and energy densities of 160 Wh/kg. A three-cell common sump battery is currently under test.

Contractor

Alcan International Ltd., Montreal, Quebec

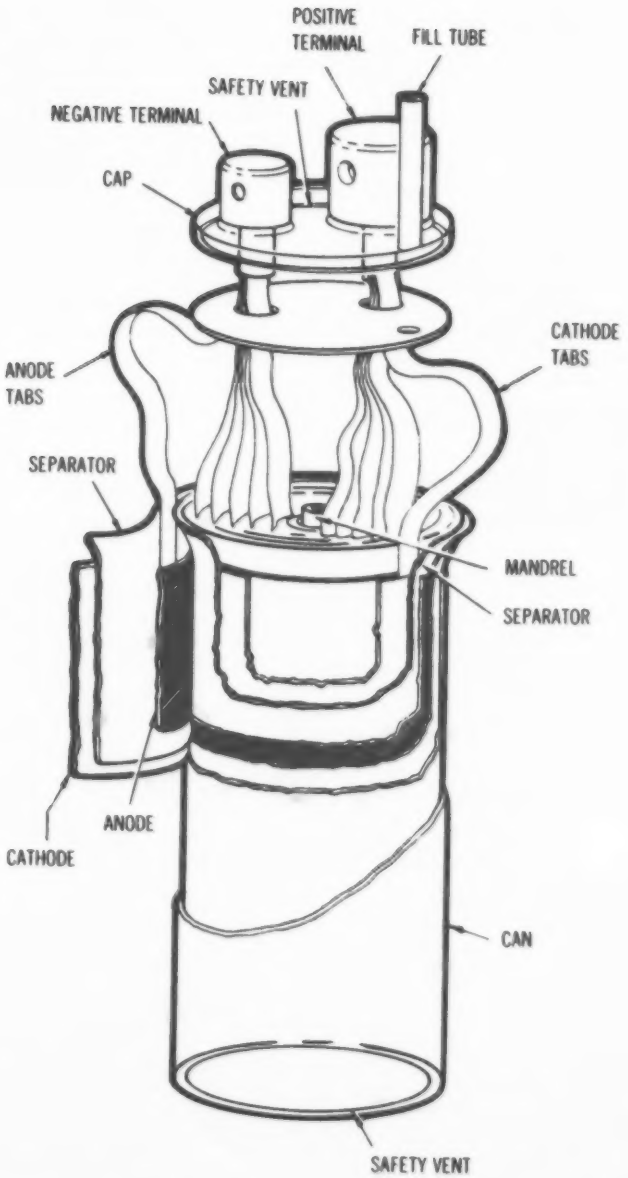
Report

None to date

Schedule: February 1985 — October 1986

Funding: TDC —	$110,000
DSS —	$109,728
EMR-Energy R&D Program —	$110,000
Total —	$329,728

Project Number: 6282
File Number: D 1465-443
Project Officer: John H. Morgan



Exploded view of cell used in the 50-ampere-hour battery

Large Moli Battery Development

Description

Advancements in electric vehicle technology could reduce Canada's current dependence on petroleum-based fuels. There is no doubt that the battery is a vital and critical element of electric vehicle (EV) development.

Recent tests conducted by Moli Energy Ltd. of Burnaby, British Columbia, suggest that the "C" size $LiMoS_2$ cell can be scaled up to "BC" size which, when incorporated into a battery, promises to yield an energy storage capacity triple that of advanced lead-acid batteries developed for EV application. This would allow the battery to undertake a much larger proportion of motor vehicle functions.

This project's aim was to develop a 50-Ah, 12-V battery that would have much greater energy storage capabilities and power delivery than a lead-acid battery.

The first phase of the project consisted of the engineering analysis, design and fabrication of the 50-Ah cell, followed by a comprehensive testing program.

Performance tests measured the battery's energy storage capacity, maximum peak and sustained power, and overall efficiency. Safety testing included short-circuit, mechanical shock and vibration, and thermal shock tests. The final testing stage addressed the battery's in-service capabilities.

Progress to June 1986

The project is complete. The scale-up of the "C" cell size to "BC" size was successful. The 50-Ah cells were constructed and tested. With a battery consisting of six cells in series, an energy storage capacity of 686 Wh, a gravimetric energy density of 94 Wh/kg, and a peak power density of 128 W/kg were demonstrated. In the present stage of development, the battery's performance is severely downgraded in temperatures below -10°C and under high discharge conditions. Additionally, the safety of the cell requires improvement in the area of thermal management of the battery under abusive conditions.

The report concluded that this technology, with some further development, is suitable for traction applications such as electric vehicles.

Contractor

Moli Energy Ltd., Burnaby, British Columbia

Report

TP 6634E, Development and testing of a large lithium molybdenum disulfide battery, Moli Energy Ltd., 1985.

Schedule: April 1984 — March 1985

Funding:	
TDC —	$ 50,000
EMR-Energy R&D Program —	$ 50,000
DSS —	$200,000
DND —	$ 20,000
Canadian Electrical Association —	$100,000
Total —	$420,000

Project Number: 6258
File Number: D 1465-416-3
Project Officer: John H. Morgan

Microcomputer-Based Integrated Traffic System

Description

Efficient regulation of traffic has several potential benefits: it can increase the capacity of existing roads and highways; reduce vehicle energy consumption by reducing the number of stops and starts; improve the level of service to drivers by reducing delays and congestion; and, reduce the cost of maintenance through better use of resources. The advent of the microprocessor and the development of several standard traffic analysis programs provide traffic engineers with some of the tools necessary for efficient traffic regulation, including the ability to easily re-time signals. Yet, these programs have still not been integrated and there is no data base that can be conveniently used with all of the programs.

This project has two objectives: to determine the requirements of an integrated traffic system, and to assess the market potential for such a system.

Progress to June 1986

The project is complete. The study concluded that an integrated traffic system can offer significant benefits: reduced energy consumption, delay and congestion, and improved safety and staff utilization. The main functions of the system would be accident analysis, traffic operations and inventory systems. The study also concluded that the system should be non-proprietary and designed to adapt and evolve with new hardware and new application software.

Contractor

IBI Group, Toronto, Ontario

Report

TP 6747E, Microcomputer based integrated traffic system — phase 1: market study and conceptual design, IBI Group, 1985.

Schedule: June 1985 — June 1986
Funding: EMR-Energy R&D Program — $30,000

Project Number: 6308
File Number: D 1465-444
Project Officer: Ling Suen

Freeway Traffic Flow Management

Description

Efficient movement of vehicles on urban freeways requires that congestion be minimized, traffic flow be maintained at moderate speeds, and supporting functions such as access ramps, emergency routes, and signs be effective.

The objective of this project is to study the feasibility of developing a traffic management system for the heavily congested corridor formed by Autoroute 25 and the Métropolitain, Décarie, and Ville Marie expressways in Montreal. The system would optimize traffic flow without construction of additional infrastructure.

Researchers will: review the effectiveness of traffic rules relating to ramp access, emergency vehicles and other traffic conditions; develop a system of directing drivers through traffic disturbances; and, develop traffic management techniques that will increase the capacity of the corridor.

If a freeway management system is found to be feasible, it will not only provide relief for current congestion, but will also provide valuable insights into traffic flow applicable to other urban corridors.

Progress to June 1986

Work on the project has not yet started.

Contractor

Not yet selected

Report

None to date

Efficient use of freeways can increase their capacity

Schedule: June 1986 — August 1987

Funding: ERDA —	$125,000
Transports Québec —	$125,000
Total —	$250,000

Project Number: 6661
File Number: D 1465-462-2
Project Officer: Catherine Hirou

Prototype ITIS unit at Skytrain station in Vancouver

The computer heart of ITIS

Integrated Transportation Information System (ITIS) Demonstration

Description

People who live in, or travel through, Canadian cities need quick access to accurate, comprehensive information about public and para-public transportation services and traffic conditions. Modern communications technologies and data bases make such information-accessing feasible.

Oracle Communications Inc. of Burnaby, British Columbia, developed a concept for a multi-mode, multi-media integrated transportation information system (ITIS). The concept was designed for the Vancouver area. It offers information about traffic conditions, public transit schedules, intercity transportation and hospitality services. Individuals have access to the information by telephone, home computer, special video displays in designated centres and possibly cable TV.

The heart of the system is a computer that stores and updates information in an extensive data base. The computer receives inquiries from the public and gives answers either as a video picture or as a synthesized voice message.

The objective of this project is to develop the ITIS concept for use in Vancouver and to demonstrate a prototype system during Expo 86.

Progress to June 1986

An ITIS prototype comprising eight information-access units, each located at a Skytrain station, is being used experimentally in Vancouver to provide information on urban transit.

Contractor

Oracle Communications Inc., Burnaby, British Columbia

Report

None to date

Schedule: May 1985 — November 1986

Funding: TDC —	$536,000
DSS —	$250,000
TDPP —	$ 50,000
Total —	$836,000

Project Number: 6399
File Number: D 1450-151
Project Officer: John H. Morgan

Standards for Left-Turn Signal Phasing

Description

Traffic signals controlling left turns are not consistent across Canada. This often causes confusion at intersections, which in turn results in inefficient traffic flows and accidents.

The objective of this project is to develop standards for left-turn signal phasing, system displays and vehicle clearance intervals.

In the first phase of the project, a study group was formed comprising representatives from major municipalities in each province. Liaison was established with similar groups in the United States. A questionnaire was sent to major Canadian urban centres to obtain information on the various signal displays currently in use.

Phase two of the project will develop recommendations for standard left-turn signals consistent with the requirements of the Council on Uniform Traffic Control Devices.

Progress to June 1986

Investigators are studying the comments from the study group, responses to the questionnaire, results from field studies and the literature.

Contractor

De Leuw Cather Canada Ltd., Ottawa, Ontario

Report

None to date

Schedule: October 1985 — September 1986
Funding: EMR-Energy R&D Program — $29,550

Project Number: 6358
File Number: D 1465-452
Project Officer: Catherine Hirou

SCAT Demonstration

Description

Disabled and elderly persons need help moving themselves and their luggage through large passenger terminals, such as airports, and through outdoor recreation areas. Although these kinds of facilities are growing larger and more complex, they usually lack adequate provision for the disabled and the elderly.

TDC has supported the development of an electric modular vehicle to meet this need. Called SCAT (small carrier for alternative transfer), it can transport several people in wheelchairs or on seats, plus luggage. Only one attendant is required to operate it.

SCAT comes in two models. The outdoor model can carry seven people at speeds up to 16 km/h. The indoor model is smaller and less powerful. Both models feature a barrier-cum-ramp for wheelchairs.

The objective of this project is to demonstrate both models in Vancouver during Expo 86.

Progress to June 1986

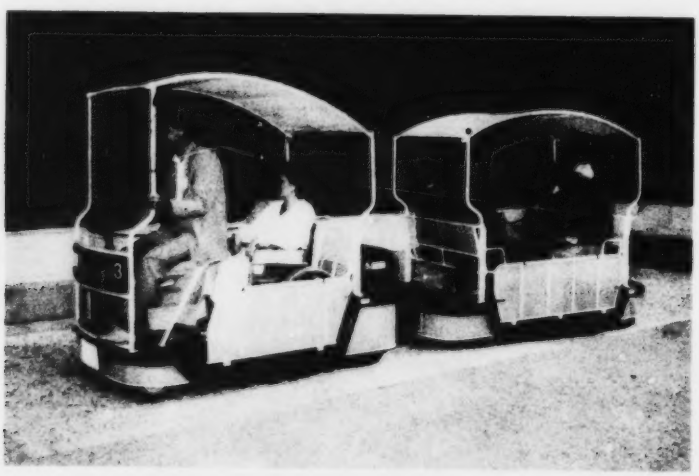
The indoor SCAT is being used at Vancouver International Airport, where several airlines are evaluating its utility. The outdoor model is being used to shuttle people between the VIP lounge and the Canadian Pavilion at Expo 86.

Contractor

Rutenberg Design Inc., Dorval, Quebec

Report

None to date



The outdoor SCAT in service at Expo 86.

Schedule: October 1984 — October 1986
Funding: TDC — $36,518

Project Number: 6268
File Number: D 1450-103-41-2
Project Officer: John H. Morgan

Lightweight Electric Wheelchair Development

Description

Battery-powered wheelchairs provide greater mobility for many disabled people. However, current battery-powered chairs inhibit some kinds of travel. Transport Canada regulations permit the transport of lead-acid batteries in larger aircraft only, which means powered-chair users must arrange for batteries to be supplied at the destination point of their flight. Handicapped persons who drive their own cars or frequently take taxis also avoid using electric wheelchairs because they are too heavy to be easily lifted into the trunk.

The objective of this project is to develop a lightweight, ergonomically sound wheelchair, powered by a lightweight battery.

Progress to June 1986

Researchers have developed a novel design. It features: three large-diameter wheels for a more comfortable ride; a disc motor that uses a permanent magnet with a high-energy density, built into the hub of the driving wheel; power steering controlled by a joy stick; limited movement of the rear wheel at high speeds for safety; and, use of plastics to permit ergonomic tailoring to specific users. The total weight of the new design is less than 20 kg, compared with 30 to 35 kg for current powered chairs. The top speed of the wheelchair is expected to be 8 km/h. Work on the battery is continuing.

Contractor

B.C. Hydro and Power Authority, Surrey, British Columbia

Report

None to date

Schedule: February 1985 — November 1986
Funding: DSS — $200,000

Project Number: 6361
File Number: D 1450-103-64
Project Officer: John H. Morgan

Hybrid Wheelchairs: A Study of Regulatory and Safety Issues

Description

There has been a rapid increase in the number and type of motorized vehicles for disabled people. These vehicles, called hybrid wheelchairs, vary in design, range, speed and ability; some resemble tricycles, scooters or small automobiles. Such hybrids are often used in environments where they compete for space with pedestrians and/or conventional vehicles.

The objective of this project was to review the issues concerning on-road use of hybrid wheelchairs and propose safety, equipment and licensing standards.

Progress to June 1986

The project is complete. The researchers concluded that special legislation and regulations are required for on-road use of hybrid wheelchairs. They proposed a preliminary classification system for these vehicles based on potential speed: up to 15 km/h, from 16 to 25 km/h and from 26 to 50 km/h. Testing of existing vehicles for performance and crashworthiness is required before safety standards can be developed.

Contractor

De Leuw Cather Canada Ltd., Ottawa, Ontario

Report

TP 6690E, Special mobility vehicles for elderly and disabled persons: regulatory and safety issues, De Leuw Cather Canada Ltd., 1985.

Sierra scooter, made in the United States

Schedule: February 1985 — July 1985
Funding: TDPP — $29,860

Project Number: 6079
File Number: D 1450-103-58
Project Officer: Barbara A. Smith

Accessible Commuter Rail for Disabled Persons

Description

A major decision faces transportation experts in planning for the needs of disabled travellers: whether to develop parallel or integrated systems. Parallel systems, popular with urban transit operators, provide special vehicles for disabled persons over routes developed specifically to serve their needs. The integrated approach provides accessibility to vehicles and facilities on regular transit systems.

Commuter rail services in Canada are not currently accessible to the disabled. Whether they should be is a question that is causing great controversy. The objective of this study was to develop a rational and systematic method of evaluating and choosing among the options.

Progress to June 1986

The project is complete. The contractor developed an evaluation and decision-making framework. The possibility of modifying two commuter rail routes, the Lakeshore West line in the Toronto area and the Rigaud line in the Montreal area, was examined. Researchers evaluated the cost effectiveness, over 30 years, of providing an integrated service, a partially integrated service and a parallel service using vans, buses and taxis.

Contractor

James F. Hickling Management Consultants Ltd., Ottawa, Ontario

Reports

TP 6926E, Accessible commuter rail for the disabled: an evaluation and decision-making framework, James F. Hickling Management Consultants Ltd., 1986.
TP 6925E, Accessible commuter rail for the disabled: an evaluation and decision-making framework, summary report, James F. Hickling Management Consultants Ltd., 1986.

Schedule: March 1985 — September 1985
Funding: TDC — $106,328

Project Number: 6071
File Number: D 1450-103-56
Project Officer: Ling Suen

Student Design Competition for Pedestrian Crosswalks

Description

Transport Canada is committed to fostering the development of new technology, systems and procedures that will help make transportation services more accessible for elderly and disabled Canadians. To mark International Youth Year in 1985, TDC sponsored a student design competition for a safer, more accessible pedestrian crosswalk. The elderly currently account for two-thirds of the pedestrian accident victims in Canada.

The competition was open to senior undergraduate and post-graduate students in Canadian university schools of engineering, architecture, urban planning and environmental studies.

Each entry was required to: address the design of urban crosswalk systems and/or pedestrian ways external to buildings and activity centres; improve access for elderly and disabled pedestrians; reduce conflicts between vehicular and pedestrian traffic, thereby improving traffic safety; and, contribute to an improved level of crosswalk design or better documentation of existing design practice. Entrants had to consider numerous factors in their designs, including street furniture, bus shelters, signs, transit information displays and traffic control devices. Both current and emerging technology could be used.

Progress to June 1986

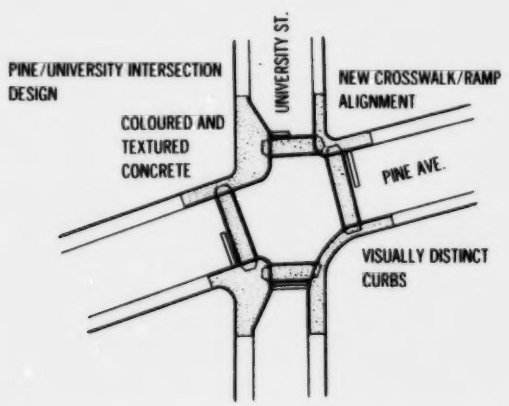
The competition winner was the team of Torill Kove and Thomas Leathem of McGill University. Their entry addressed the unique problems for the elderly and the disabled presented by the intersection of University Street and Pine Avenue in Montreal.

Contractor

MANOP Services Ltd., North Vancouver, British Columbia

Report

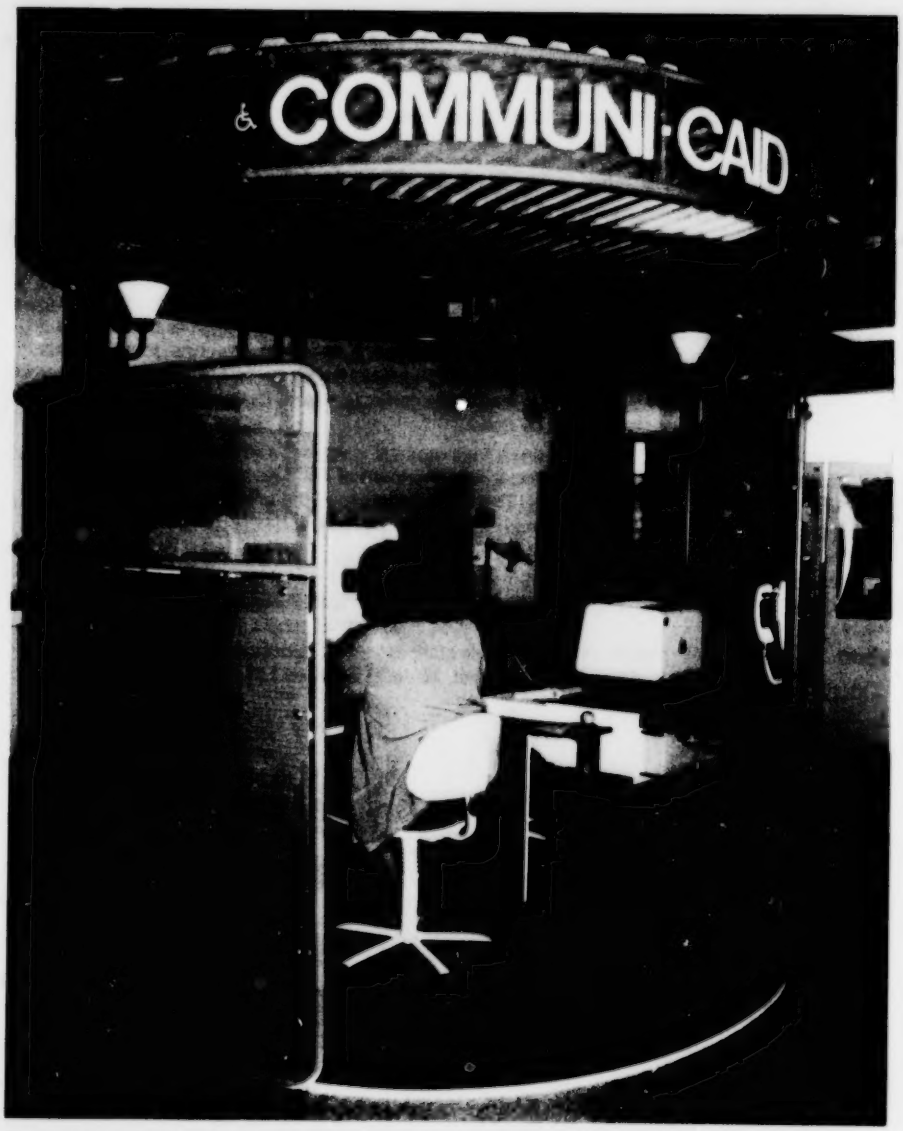
TP 7346E, Student design competition for pedestrian crosswalks: an International Youth Year project, MANOP Services Ltd., 1986.



Top prize was awarded for this intersection design, which also specifies improved signage, traffic lights and light cycles.

Schedule: September 1985 — March 1986
Funding: TDC — $34,000

Project Number: 6520
File Number: D 1450-103-70
Project Officer: Barbara A. Smith



The prototype Communi-Caid system in operation at Vancouver International Airport.

Communication Aids at Transportation Terminals

Description

Technology exists that could make travel easier for persons with sensory and speech impairments, but communicating devices have not been designed to suit the specific needs of passengers and carrier agents in transportation terminals.

The objective of this project was to design a system of integrated communication aids for persons with sight, speech or hearing impairments. The main development effort was to identify suitable state-of-the-art communications systems and resolve interface problems.

Progress to June 1986

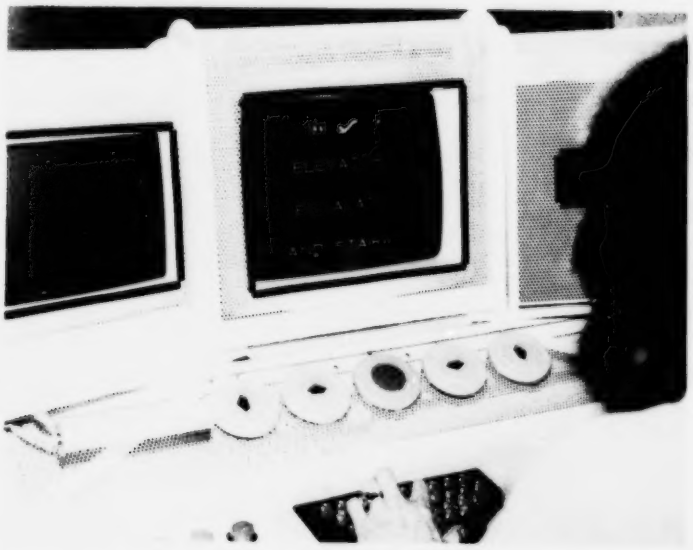
Researchers conducted an extensive literature search to identify available technologies, and compiled an exhaustive list of the human factors involved in the use of an integrated system. Specifications for a system were developed. A prototype system using a display screen, keyboard, printer, speech synthesizer and telephone-type receiver is being demonstrated at Vancouver International Airport. The computerized system permits travellers to obtain site-specific information from agents and ticket clerks without the assistance of an attendant.

Contractor

Rutenberg Design Inc., Dorval, Quebec

Report

None to date



Communi-Caid provides information on airport facilities, flight arrivals and departures, ground transportation services, and facilities for disabled travellers at Expo 86.

Schedule: November 1984 — October 1986

Funding: TDC —	$180,000
DSS —	$100,000
EDA —	$100,000
Total —	$380,000

Project Number: 6293
File Number: D 1450-103-44
Project Officer: John H. Morgan

Portable Train-Based Wheelchair Lift

Description

VIA Rail has no efficient method of helping wheelchair passengers to board its trains. Montreal's Central Station is the only station in Canada with raised platforms permitting direct access for wheelchairs to trains. And while one electrical and twenty manual lifts have been installed in major stations across Canada, the manual lifts are so slow that many attendants choose to carry wheelchair passengers aboard. Indeed, at all small VIA stations and at most larger stations, manual boarding of wheelchair passengers is necessary.

The objective of this project is to design, build, test and evaluate a portable, on-board wheelchair lift based on a concept developed by Rutenberg Design Inc., of Dorval, Quebec. The concept is for a lightweight, portable wheelchair lift that can be easily stored on a train and deployed by one attendant.

The project consists of three phases. The first phase will culminate in construction of a mock-up of the lift for review by VIA Rail and TDC. During this phase, the contractor will study the human factors involved in the assembly and operation of the train-based lift. During the second phase, an experimental prototype will be built and tested on selected types of VIA mainline trains. The third phase will review the test results and modify the prototype as necessary.

Progress to June 1986

The project has just begun.

Contractor

Rutenberg Design Inc., Dorval, Quebec

Report

None to date

Schedule: April 1986 — April 1987

Funding: TDC —	$38,250
VIA Rail —	$50,860
Total —	$89,110

Project Number: 6466
File Number: D 1450-103-68
Project Officer: Barbara A. Smith

Transfer Chair Evaluation

Description

The stairs of intercity buses present a barrier to some elderly and mobility impaired travellers. Many ambulatory travellers who cannot navigate the steep steps of intercity buses must be carried on and off vehicles by attendants or by bus terminal employees. To alleviate this problem, TDC supported the construction of five prototypes of a terminal-based lift system that could be used to board mobility handicapped passengers by lifting them from outside an intercity bus to the aisle of the vehicle.

The successful deployment of a terminal-based system would make intercity travel more accessible to passengers with limited mobility, without resorting to the expense of equipping every bus with an on-board lifting device. It would also relieve terminal employees of the responsibility of carrying such travellers.

The objective of this project is to test and evaluate the prototypes to determine their acceptability for an in-service demonstration.

Progress to June 1986

Results of the testing of the prototypes are currently under review by TDC.

Contractor

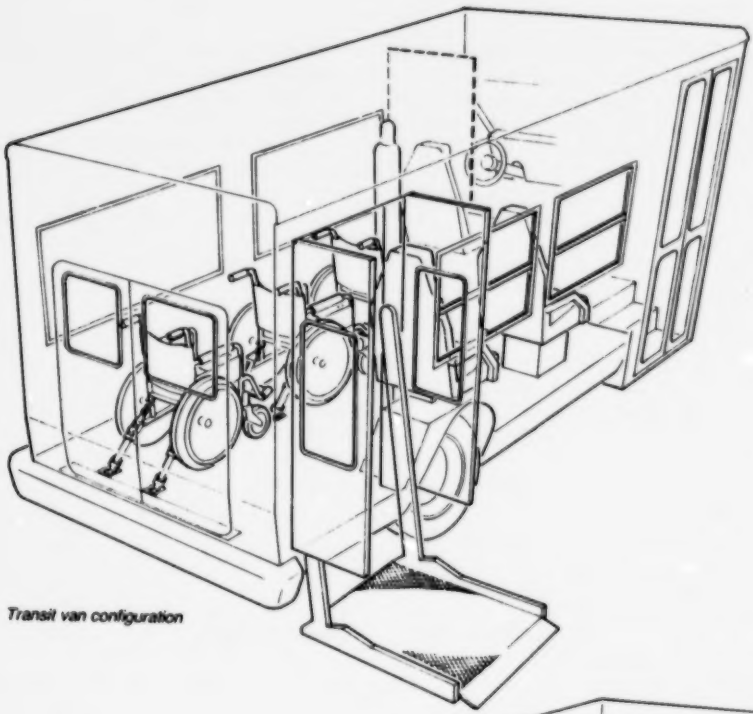
De Leuw Cather Canada Ltd., Ottawa, Ontario

Report

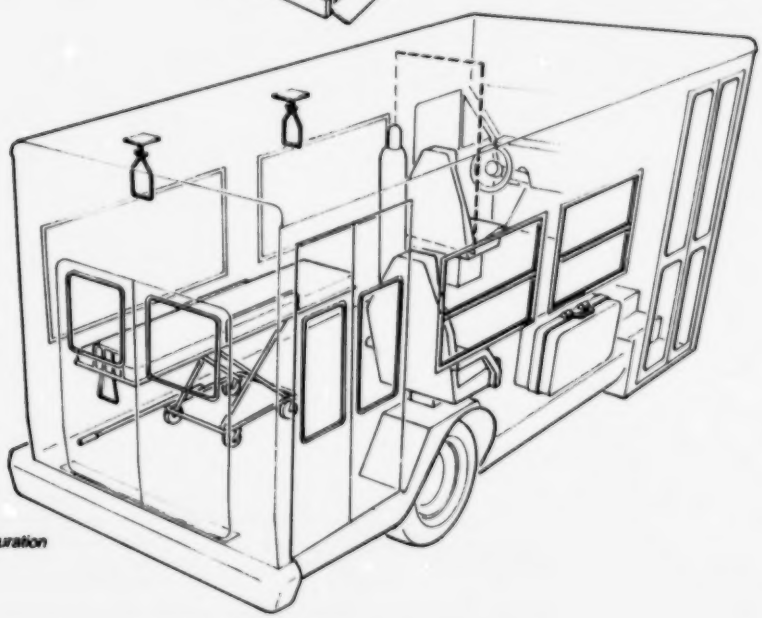
None to date

Schedule: May 1986 — December 1986
Funding: TDPP — $85,000

Project Number: 6538
File Number: D 1650-103-66
Project Officer: Catherine Hirou



Transit van configuration



Ambulance configuration

Multi-Purpose Vehicle Development

Description

Small or isolated communities sometimes have difficulty meeting the transportation needs of elderly and disabled persons. Paratransit systems using dedicated vehicles are costly. At the same time, many communities have purpose-built ambulances that are underused: a survey taken in 1982 in Manitoba found that some ambulances had as few as seven calls per year.

Both the federal government and the government of Manitoba have determined that paratransit and ambulance services could be more efficiently provided by a vehicle designed to serve both purposes. The vehicle would be designed primarily to provide transportation for elderly and disabled persons, but could be quickly transformed into an ambulance.

Previous projects have developed detailed specifications for such a multi-purpose vehicle. Plans have also been completed for a demonstration program in a rural community. The objective of this project was to build a prototype of the vehicle.

Progress to June 1986

The prototype vehicle has been fabricated. The vehicle will be delivered to the government of Manitoba for demonstration in the summer of 1986.

Contractor

TES Ltd., Ottawa, Ontario

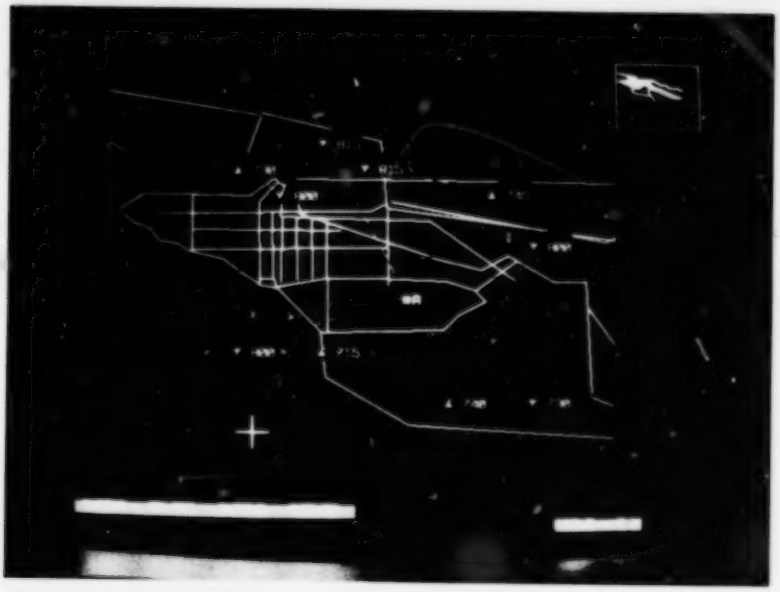
Report

TP 7435E, Multi-purpose vehicle for integrated rural service: development of specifications/prototype vehicle for demonstration program, TES Ltd., 1986.

Prototype of the multi-purpose vehicle to be tested in demonstration service in Minitonas, Manitoba

Schedule: October 1985 — March 1986
Funding: TDPP — $51,197

Project Number: 6545
File Number: D 1450-103-74
Project Officer: Roy S. Nishizaki



DART Manager graphics display

DART Manager data display

Computerized Scheduling/Brokerage Demonstration of Special Public Transit Services

Description

The demand for special public transit services for disabled people is growing rapidly. As such transit services expand and become more complex, efficiency and availability become increasingly important. TDC has already supported such innovations as a computer-assisted reservation and scheduling system and a computer model for route planning.

The next challenge is to develop a computer program that will allow a central dispatcher to efficiently assign all of the special transit facilities available to disabled people in a given locale.

The objective of this project is to develop and demonstrate a generic computerized scheduling/brokerage system to provide optimum service for disabled travellers. The system matches supply and demand by exchanging information between clients and transit operators. It also "learns" from previous patterns of demand to improve transit schedules and vehicle availability.

The computerized system will be demonstrated in locations that already have proven, manual dispatch systems in operation. Researchers will analyze the degree of automation required at each candidate location. The existing dispatch systems will be automated and their effectiveness compared with automated dispatch systems already in use elsewhere. The best system will then be expanded into a network operation capable of dispatching special vehicles from each of the individual locations.

The decentralized, automated scheduling/brokerage software will be demonstrated first in Vancouver, during Expo 86. A centralized computer dispatch operation will be demonstrated later in Edmonton.

Progress to June 1986

Two microcomputer software packages, called DART Manager, are being tested in daily operation by a custom transit operator serving the central city of Vancouver and municipalities. The system is currently being extended to the other six custom transit operators in the region. By the end of 1986, the enhanced DART Manager with added scheduling features will be available as a multi-user package with full documentation.

Contractors

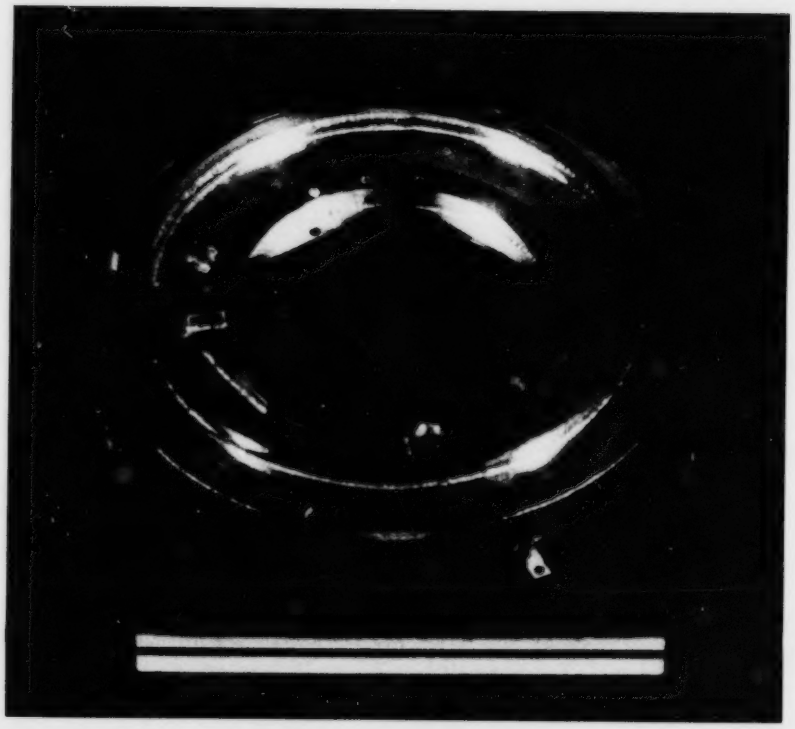
BC Transit, Vancouver, British Columbia
City of Edmonton, Edmonton, Alberta

Reports

TP 6884E, DART, Dial-a-ride transit manager user manual, BC Transit, 1985.
Draft, The Vancouver computerized scheduling/brokerage demonstration, final evaluation report, BC Transit.
Draft, The Vancouver computerized scheduling/brokerage demonstration, executive summary, BC Transit.
Draft, DART Manager Plus, version 1.1, BC Transit.
Draft, DART Manager Plus, version 2.1, BC Transit.
Draft, DART Manager Graphics, version 2.1, BC Transit.

Schedule: March 1985 — March 1987
Funding: TDC — $ 23,000
TDPP — $242,288
Total — $265,288

Project Numbers: 6387, 6416
File Number: D 1450-103-67-2
Project Officer: Ling Suen



Small superconducting coil and frame. Mean coil diameter is 30 cm.

Coil and frame for model racetrack. Mean length is 106 cm; end radius is 15 cm. The impregnated winding has been removed and sectioned for inspection.

Canadian Maglev System Development

Description

TDC has a long-term research and development program for a tracked, magnetically levitated (Maglev) passenger transportation system. Researchers are looking to Maglev to provide a possible long-term alternative for intercity passenger transportation, particularly in the densely populated Montreal-Ottawa-Toronto corridor. A Maglev system would offer smooth, quiet and safe ground transportation at speeds approaching 500 km/h. It would not use petroleum-based fuels, nor would it produce noise or air pollution.

The National Research Council (NRC) appraised the Maglev design concepts developed for TDC by the Canadian Maglev Group. The NRC subsequently produced a final integrated system and vehicle concept. A site-specific, techno-economic study conducted by the Canadian Institute of Guided Ground Transport (CIGGT) concluded that a Maglev system would be significantly less expensive to operate than conventional intercity transport modes. It also indicated that a key element in the Maglev concept — the superconducting magnet and its support systems — needs further development.

The objective of this project is to develop an effective method of constructing and testing a superconducting coil. The coil must be large enough to simulate a full-scale magnet. Researchers are investigating the use of epoxy impregnation techniques to build the coil.

This development effort should enhance the feasibility of the Canadian Maglev concept. It will also increase Canadian knowledge and experience of superconductivity, which may find application in other transportation fields, such as the development of superconducting DC motors for marine use.

Progress to June 1986

Fabrication and testing of the coil are complete. A winding fill factor of 80 per cent was achieved. The coil was successfully energized to more than 15 per cent above its design value, which indicates a high degree of mechanical integrity within the winding and support frame.

Contractor

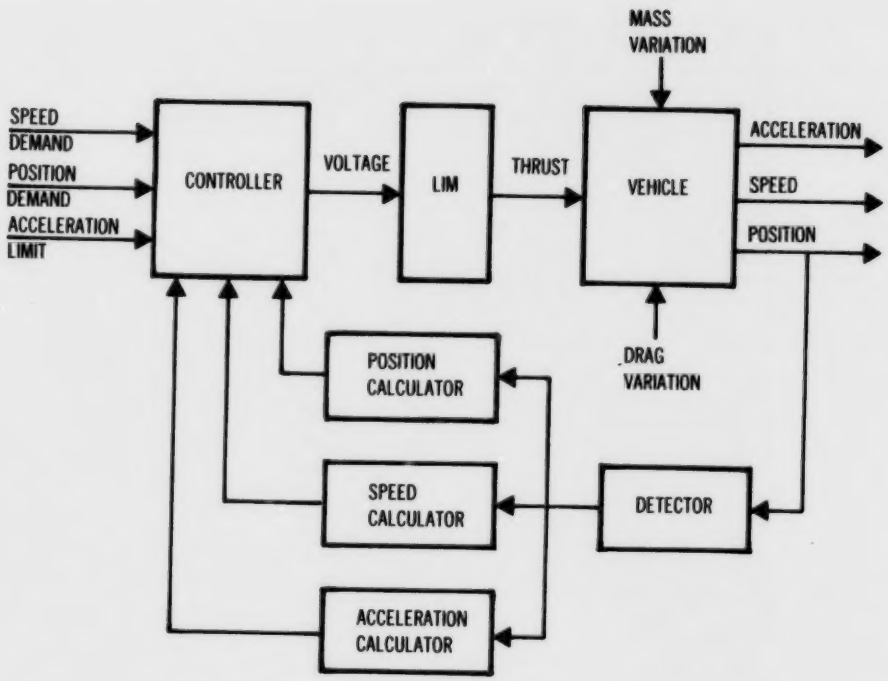
CTF Systems Inc., Port Coquitlam, British Columbia

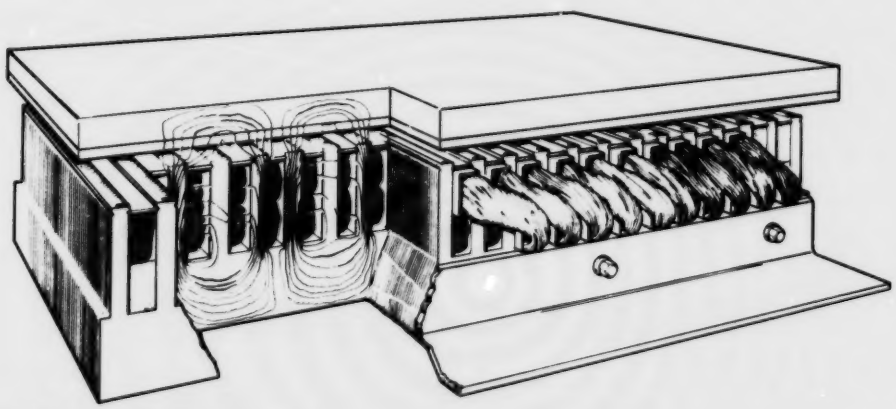
Report

Draft, Fabrication and testing of a reduced-scale superconducting magnet, CTF Systems Inc.

Schedule: September 1984 — November 1986
Funding: TDC — $373,544

Project Number: 6207
File Number: D 1465-269-3
Project Officer: Maurice Audette





Linear induction motor and its control system

Advanced Linear Induction Motor and Propulsion Control Research

Description

TDC has supported research into the linear induction motor (LIM) since 1979. This non-contact propulsion technology offers scope for several novel transportation applications. Of particular interest in recent years have been LIM configurations featuring passive vehicles: the LIM primaries are located in the track, while the traction member is located on the vehicle. These configurations allow the track to be flush with the floor, removing obstacles to foot traffic and wheeled vehicles.

The objective of this project is to further the development of LIM technology in three areas: microprocessor power control, slip-power recovery and LIM self-steering.

In present configurations, each LIM in the track is connected directly to a power control panel, necessitating extensive cabling along the track. Relays switch the motors on and off as required. Microprocessor power control would permit the use of a single bus bar for selecting power.

Existing LIM drives suffer some power loss due to slippage as the reaction rail passes over the LIM primary. If this slip power were recovered, it could be applied to charging on-board batteries, lighting, braking and steering.

Finally, researchers will attempt to exploit the self-aligning characteristics of the reaction rail to develop a self-steering system for LIM vehicles.

There are many potential applications for LIM systems in transportation and industry. Already being considered are low-power people movers for transportation terminals, material-handling systems and applications to innovative production line procedures.

Progress to June 1986

Operating requirements have been established for a prototype system. A fixed-frequency, variable-voltage power and control package and LIM have been designed and are being built. Testing is planned for the summer of 1986.

Contractor

Transportation Technology Ltd., Kingston, Ontario

Report

None to date

Schedule: November 1985 — March 1988

Funding: TDC —	$300,000
DSS —	$200,000
Total —	$500,000

Project Number: 6599
File Number: D 1465-427-2
Project Officer: C. Alfred Versailles

Slurry Pipeline Manual

Description

The Alberta government is evaluating a future water/coal slurry pipeline from Hinton, Alberta, to Kitimat, B.C. A consortium of industries is considering building a slurry pipeline from Coal Spur, Alberta, to Vancouver. This growing interest in slurry pipeline technology has created a need for a definitive manual on the subject.

Since the early 1970s, TDC has supported pioneering research on slurry pipelines at the Saskatchewan Research Council and the University of Saskatchewan. The province is now recognized as a centre of excellence in pipeline technology.

The objective of this project is to write a comprehensive manual on slurry pipeline construction standards and engineering practices. The manual will be used by planners, engineers and economists considering slurry pipeline installations. The work necessary to produce the manual will also serve to review the current state of slurry pipeline technology, thus permitting researchers to identify any knowledge gaps in the field. Research programs can then be defined to fill these gaps and ensure the integrity of future pipeline installations.

Progress to June 1986

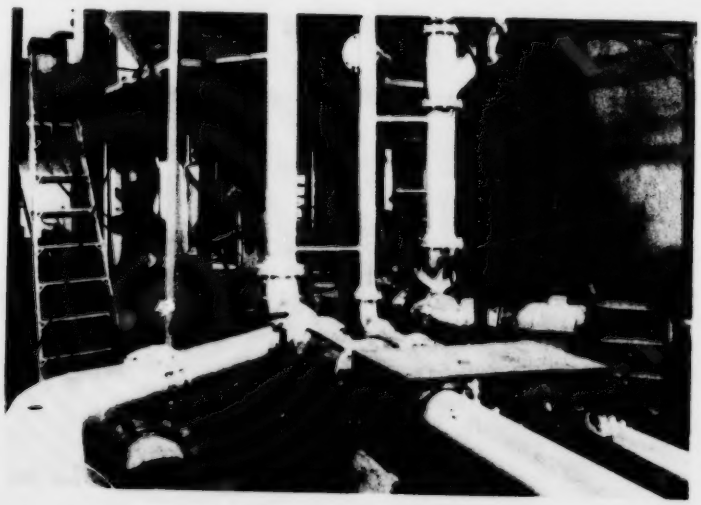
The manual has been written. It is scheduled for publication in September 1986.

Contractor

Saskatchewan Research Council, Saskatoon, Saskatchewan

Report

Draft, Slurry pipeline manual: design and construction, Saskatchewan Research Council.



Slurry Pipeline Development Centre at the University of Saskatchewan

Schedule: November 1983 — September 1986
Funding: EMR-Energy R&D Program — $141,300

Project Number: 6068
File Number: D 1467-100-5
Project Officer: Wayne G. Rowan

Arctic Snowmobile Evaluation

Description

The snowmobile has become an integral part of the transportation system in Canada's northern regions. It provides personal transportation in a style that is acceptable to the local population, and has largely replaced the traditional dog sled. The snowmobile has become essential for hunting and trapping and is the principal means of short-distance travel.

The recreational snowmobile used in southern Canada is not sufficiently rugged or reliable for the North. Most break down after only one year of operation in rugged Arctic service. In 1983, a TDC-sponsored study developed a concept for a more rugged, utility snowmobile. It would be capable of pulling a half-ton sled over long distances, would last ten times longer than a recreational snowmobile and would be offered in kit form suitable for assembly in northern communities. Its price would be competitive with that of current recreational vehicles.

The objective of this project is to design, construct and evaluate two prototype models of the utility snowmobile. Both the operating characteristics of the vehicle and the assembly and inspection of the kits in a northern environment will be evaluated. Since the snowmobile has become essential to the economy of northern communities, improved reliability at no increase in cost represents a real benefit to these communities.

Progress to June 1986

The vehicles have been built and are being tested in the North.

Contractor

Nunasi Corporation, Ottawa, Ontario

Report

TP 7760E, Arctic snowmobile prototype, Nunasi Corporation, 1986.

Prototype Arctic snowmobile

Schedule: October 1985 — September 1986
Funding: TDC — $100,000
Other — $ 60,000
Total — $160,000

Project Number: 6541
File Number: D 1465-320-3
Project Officer: Jacques E. Laframboise

Aerobac Cost Study

Description

The Aerobac is an off-road, amphibious vehicle concept that integrates an air cushion lift system with caterpillar traction. The vehicle is intended to provide rapid ground transportation over surfaces with inferior soil strength in areas where the traffic volume is too low to justify the cost of roads. The vehicle concept includes passenger models as well as utility models capable of carrying payloads of up to 20 tonnes. Characteristics of the Aerobac include:

- low surface contact pressure,
- mobility of tracks, on and off cushion, and
- no need for special driving skills.

TDC supported a study to analyze the effectiveness of the Aerobac AB-7, a seven-tonne payload model, as a rescue vehicle at airports where surface conditions around the runways and taxiways make access by existing vehicles difficult or impossible. Simulations showed that the Aerobac could respond to aircraft accidents occurring within the critical access area of airports within three to four minutes over difficult terrains such as snow, muskeg or mud.

The objective of the latest study was to analyze the cost of developing a prototype vehicle.

Progress to June 1986

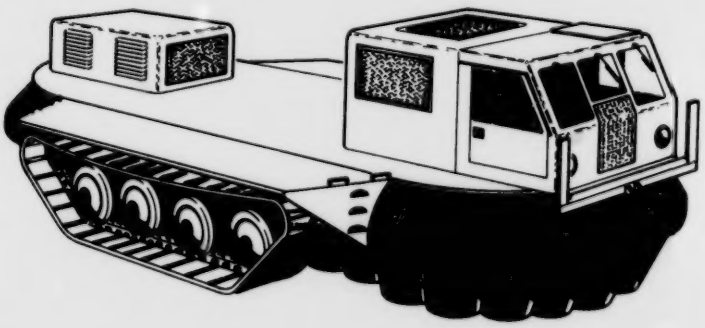
The project is complete. The report presents a plan for the construction of the prototype, identifying possible supporting organizations, suppliers of parts and services and expected delivery dates. Production cost of the prototype is estimated at C$2 million.

Contractor

VITRI Robots and Vehicles Inc., Boucherville, Quebec

Report

Non-releasable



Artist's concept

Schedule: March 1985 — January 1986
Funding: TDC — $15,000

Project Number: 6507
File Number: D 1465-258-6
Project Officer: Jacques E. Laframboise

Transportation Management Game: JET-SET

Description

Simulation games have proven to be an effective training tool for the transportation industry. For example, the Transport Canada Training Institute (TCTI) has had positive feedback from students using BusCompete, a simulation game developed by the World Bank in which six teams operate six competing bus companies. The success of BusCompete prompted interest in the development of a multimodal simulation exercise involving bus, rail and air transportation.

In a project supported by TDC and TCTI, the Université de Montréal developed JET-SET, a transportation game for six players or teams, each of whom manages one passenger transportation company. At the start of the game, players receive operational and financial reports of their company as well as general socio-economic information. Based on these data, players make a number of decisions — services, schedules, rates, purchases, marketing strategies, etc. — which have a direct impact on their company's performance. At the end of each game cycle, players receive a status report describing the changes in their company as a result of both their decisions and the decisions of the other players. The game continues through successive cycles.

JET-SET, which runs on an Apple IIE computer, has generated favorable reaction from TCTI students and has attracted the attention of transportation planners in both the United States and Canada. The game is being used by several private sector and governmental organizations.

The objective of this project was to develop another version of JET-SET, which will run on an IBM-PC and which will realistically represent the Canadian passenger transportation context.

Progress to June 1986

The project is complete. JET-SET was tested at TCTI during the summer of 1985. The game's logic was adjusted and the game converted to run on an IBM-PC.

Contractor

Centre de recherche sur les transports, Université de Montréal, Montreal, Quebec

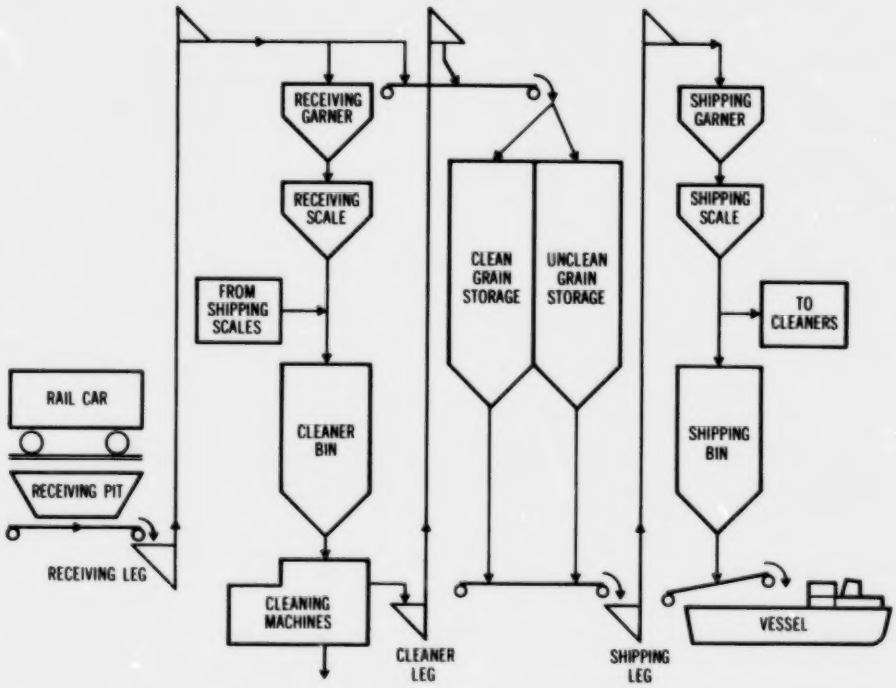
Reports

TP 6477E, JET-SET, Jeu éducatif en transport/Simulation for education in transportation — part 1: operation and rules of the game, Centre de recherche sur les transports, Université de Montréal, 1985.
TP 6566E, JET-SET, Jeu éducatif en transport/Simulation for education in transportation — part 2: user's manual for the APPLE IIE version, Centre de recherche sur les transports, Université de Montréal, 1985.
TP 6565E, JET-SET, Jeu éducatif en transport/Simulation for education in transportation — synthesis, Centre de recherche sur les transports, Université de Montréal, 1985.

Schedule: July 1984 — December 1985

Funding: TDC —	$53,000
TCTI —	$10,000
Total —	$63,000

Project Number: 6272
File Number: D 1450-145
Project Officer: Catherine Hirou



Schematic of grain elevator operation

Grain Terminal Simulation Project

Description

In a $45 million program to upgrade its Vancouver grain terminal, Alberta Wheat Pool plans to invest $17.5 million in computer-based operations management and control. As part of this program, $1.7 million will be spent on a joint government/industry R&D project to develop the software and additional hardware required to incorporate an interactive operational simulation into the system. The end result of this project will be the demonstration of a full-scale prototype installation of an advanced planning, monitoring and control system for the terminal.

Under manual control, a grain elevator cannot achieve high efficiency consistently. The three processing functions — receiving, cleaning and shipping — are highly interdependent, owing to limited storage space and shared equipment. Such minute-by-minute decisions as storage bin selection, choice of transfer equipment and routing are made on the basis of limited information, and without any clear understanding of long-term impact.

The interactive operational simulation system will be closely coupled with a computer-based terminal operations management and control system. Together, the systems will receive and display all relevant information for the operators, allow decisions to be tested, prior to implementation, for their immediate and long-term impact, and automatically implement decisions once they are made.

Parallel to, and in conjunction with, this project, the National Research Council (NRC) is working on control techniques for more general application. This work will provide tools for use by other grain companies, transportation companies and government agencies. NRC will develop a model for investigating the performance of the entire grain handling system under different operating strategies and physical configurations.

Progress to June 1986

This project has just started.

Contractor

Alberta Wheat Pool, Vancouver, British Columbia

Subcontractor

DATAP Systems, Vancouver, British Columbia

Report

None to date

Schedule: November 1985 — March 1988

Funding: TDC —	$ 100,000
DSS —	$ 300,000
NRC —	$ 320,000
DRIE —	$ 200,000
Alberta Wheat Pool —	$ 780,000
Total —	$1,700,000

Project Number: 6486
File Number: D 1465-463
Project Officer: Brian Marshall

Rail Network Simulation for Port Operations

Description

Major changes are needed in the rail network at the Port of Montreal to improve container handling efficiency. The rail network is so complicated that careful planning is required before any changes can be introduced. Both CN Rail and CP Rail serve the port, which has 100 km of track serving terminals, warehouses, wharfs and industry. A change to a siding may adversely affect traffic patterns or loading operations in other parts of the network.

The objective of this project was to develop a computer model of the rail network in the port to assist port operators in plan changes.

Progress to June 1986

The project is complete. The model, designed for use on a microcomputer, allows operators to see how planned changes to port facilities and the rail network will affect rail operations, and to quickly identify solutions to congestion problems. The model will be used to test short-, medium- and long-term strategies for improving container handling efficiency in the port area.

The model is flexible enough to be used at other ports, and a comprehensive user's manual is soon to be available.

Contractor

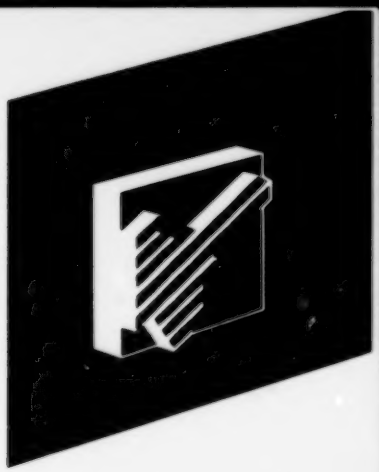
GIRO Inc., Montreal, Quebec

Reports

Draft, Logiciel de simulation des opérations ferroviaires au port de Montréal: manuel d'utilisation, GIRO Inc.
Draft, Logiciel de simulation des opérations ferroviaires au port de Montréal: modèle de simulation, GIRO Inc.

Schedule: November 1985 — March 1986
Funding: EMR-Energy R&D Program — $97,300

Project Number: 6329
File Number: D 1465-447
Project Officer: Catherine Hirou



AIR TECHNOLOGY

Air Technology

Canada's vast size and the distances between communities make air transportation vital to Canadians. TDC's air transportation technology program supports Transport Canada's needs, while stimulating cooperative R&D activities with the air industry.

Navigation

TDC's research in this area is concerned with the operational aspects of air transportation. Research into navigational aids is intended to increase operational safety and efficiency. Two major programs in this area concern the application of state-of-the-art communications technology and man/machine principles to air traffic control operations, and the development of a ground test facility for the newly introduced microwave landing system.

Airports

The objective of one group of activities in this area is the development of detection and screening systems that will assure the safety of air travel without creating unreasonable delays in boarding.

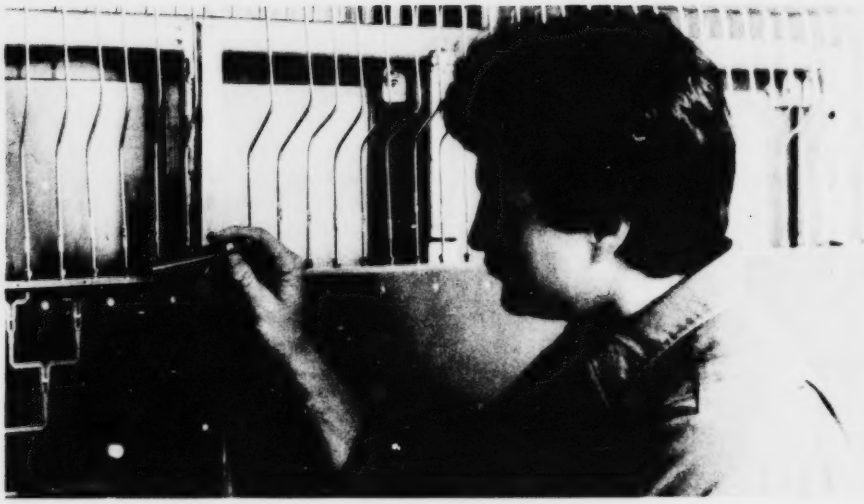
Other projects are aimed at developing design and planning concepts to increase the capacity, efficiency and productivity of air terminals.

Safety and Regulation

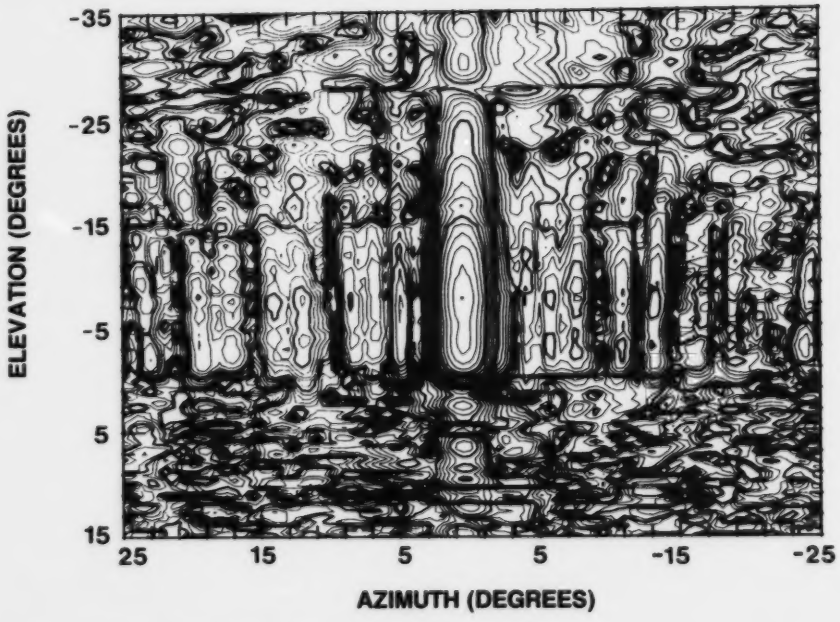
An important concern of TDC's air technology program is the improvement of safety standards in the Canadian air transportation environment. TDC is working with the Canadian Aviation Safety Board and Transport Canada's Aviation Regulations Directorate to realize this objective. Projects include: developing a voice advisory system for pilots of heavy-haul helicopters; evaluating smoke masks for air travellers; and preparing a manual to help accident investigators to analyze aircraft instruments.

Airframe and Propulsion

TDC's research in this area supports Canadian air industry in the design of innovative aircraft and engines and helps to reduce the risk level of these advanced-technology research activities. Devices, components and materials that can improve aircraft safety and energy efficiency are being investigated and developed.



Cardinal feed subsystem of antenna



Contour plot of antenna pattern; amplitude contours at 2-dB intervals

Microwave Landing System: Microstrip Antenna Development

Description

The microwave landing system (MLS) will become the primary aircraft landing system by 1995, replacing the present International Civil Aviation Organization standard UHF/VHF instrument landing system (ILS).

The MLS will provide aircraft with precision approach and landing capability through the use of sophisticated microwave and computer technology. The MLS is more accurate than the ILS, offers greater flight coverage (a total 40 degrees in azimuth and 15 degrees in elevation), and is less vulnerable to signal distortion caused by terrain irregularities and adverse weather conditions.

Introduction of the MLS will allow pilots to make smooth, direct approaches, saving time and fuel. It will also ensure safer landings at airports in mountainous regions, on oil rigs, and at other difficult locations.

The objective of this project is to develop a microstrip azimuth antenna subsystem for the MLS to replace the conventional slotted waveguide antenna currently available.

The microstrip subsystem uses series-fed, microstrip, patch radiators for the antenna. This technology offers improved cost-effectiveness and the potential for superior antenna performance. The antenna itself is also less rigid, offering less resistance to an aircraft in the event of a crash.

Progress to June 1986

A prototype vertical array microstrip has been tested successfully. The microstrip circuit boards for a full MLS azimuth antenna have been fabricated and mounted on a support structure. Testing of the full antenna revealed inconsistencies in the printed circuit board substrate composition. A second antenna was fabricated and testing is underway.

Contractor

Canadian Astronautics Ltd., Ottawa, Ontario

Report

None to date

Schedule: January 1985 — July 1986
Funding: TDC — $168,877

Project Number: 6320
File Number: D 1455-153-4
Project Officer: Micha Avni

Microwave Landing System: Ground Test Facility

Description

The microwave landing system (MLS) will become the primary aircraft landing system by 1995, replacing the present International Civil Aviation Organization standard UHF/VHF instrument landing system.

The current method of testing landing systems, both for commissioning and for certification checks, involves several hundred hours of flight time for an aircraft equipped with special instruments. The procedure is expensive, can be conducted only under good flying conditions, and disturbs scheduled air traffic.

The objective of this multi-phase project is to develop an alternative method for testing the MLS. Test facilities on the ground would significantly reduce the need for expensive airborne tests.

Three separate test facilities are envisaged: a first-article facility to conduct detailed tests on new designs of the MLS; a commissioning test-set to test new installations of proven equipment at airports; and, a certification test-set to conduct the scheduled tests required of all navigational aids at airports.

In the current phase of the project, researchers will design and implement an MLS first-article test facility, and develop a detailed engineering description for the commissioning test-set through preliminary experiments.

Progress to June 1986

Preliminary work demonstrated the feasibility of the basic design for the MLS first-article test facility. Detailed design work is complete. The facility, which will be built at the Department of Communications' David Florida Laboratory antenna test range near Ottawa, is being developed.

Contractor

Canadian Astronautics Ltd., Ottawa, Ontario

Report

None to date

Schedule: December 1985 — December 1986

Funding: TDC —	$271,941
EDA —	$ 50,000
Total —	$321,941

Project Number: 6549
File Number: D 1465-165
Project Officer: Micha Avni

Computer-Aided Learning for Air Traffic Control Electronics Technicians

Description

Transport Canada is committed to modernizing air traffic control across the country through the Canadian Airspace Systems Plan. Implementation of this plan requires special training for electronics technicians to keep them up-to-date with advances in electronics and to refresh their maintenance skills.

The objective of this project is to develop a comfortable, single-user, computer-aided learning workstation for electronics technicians. The knowledge gained from this study can be applied in many areas where sophisticated electronic systems are used.

The ergonomic study will investigate current standards for such factors as air quality, screen glare and VDT shielding. Researchers will also study: the physical features of a work station that relate to body dimensions and sensory perception; motivation and the psychology of computer-aided learning; and, available input/output devices such as keyboard, mouse, character display and audio unit.

Several layouts will be developed and tested for their effectiveness.

Progress to June 1986

A review of relevant technology has been completed. The standards defined for maintenance technician capability in Transport Canada's Radar Modernization Project have been adopted for the content and layout of the workstation.

Contractor

Sypher Consultants Inc., Ottawa, Ontario

Report

None to date

Schedule: October 1985 — September 1986
Funding: TDC — $194,983

Project Number: 6470
File Number: D 1455-166
Project Officer: Barry B. Myers

Full-scale mock-up of ATC workstation

ATC Workstation Development: Phase 1

Description

The new Canadian Airspace Systems Plan provides a strategy for improving facilities and equipment used in air traffic control to the year 2000. The plan shows how best to accommodate changing demands for services, constrain costs, restructure the technical framework and deal with aging facilities.

A major theme of the plan is that safety, capacity, productivity and economy will be realized chiefly through introduction of higher levels of automation, consolidation of certain facilities and services, and application of emerging technologies in telecommunications.

The air traffic controller workstation requires a major upgrading in technology. The workstation receives flight plan information from pilots and dispatchers and radar data from ground radar surveillance units. Some of these communication links are inefficient: flight information, for example, is passed by telephone and hand before it is entered on the air traffic control (ATC) display screen. Human factor and engineering studies are required to develop the operational and technical specifications for a new workstation.

TDC, in collaboration with Transport Canada's Aviation Group, has implemented a project to design, develop and ergonomically evaluate a prototype ATC workstation that will result in specifications for the flight data management program of the ATC workstation. The specifications can also be used for additional human factors testing and evaluation of a variety of ATC interface configurations. The project is divided into three phases:

- The research and analysis phase includes literature searches, preparation of bibliographies, site visits, task analysis of the activities of air traffic controllers, and acquisition of suitable hardware and software for producing sophisticated 3D colour graphics.
- The design and development phase will produce a prototype console, install it at the ATC Research and Experimentation Centre in Hull, Quebec, and integrate it with a pilot simulation station.
- The evaluation phase will assess the technical and ergonomical suitability of the workstation.

Progress to June 1986

The researchers have selected the hardware and the software. The Silicon Graphics IRIS 3030 has been identified as the hardware best able to produce the complex 3D graphics needed and also be compatible with the hardware at Hull. A market review of available software led to three choices: BLOX, from Ruble Software, to organize and measure the human performance issues; ALIAS I or an equivalent for solid 3D modelling; and, a standard CAD (computer-aided design) package.

Contractor

John Arnott & Associates Ltd., Toronto, Ontario

Report

None to date

Schedule: December 1985 — December 1987

Funding: TDC —	$200,000
DSS —	$400,000
EDA —	$200,000
Total —	$800,000

Project Number: 6583
File Number: D 1455-174
Project Officer: Roy S. Nishizaki

Prototype Application of Expert Systems

Description

Avoiding conflicts in aircraft flight paths is an essential function of air traffic control. Routing is currently decided by air traffic controllers on the basis of their individual expert judgment. Conventional numeric algorithms cannot be used for conflict avoidance; however, the application of an expert or knowledge-based system shows promise.

The objective of this project was to develop a computer software shell that would bring together current air traffic control expertise and use it to develop conflict-avoidance algorithms for an expert system.

Such a system could provide individual air traffic controllers with advice based on the experience of many controllers, thereby reducing workload and improving the efficiency of aircraft routing.

Progress to June 1986

The project is complete. A software shell was developed based on the experience of controllers in the non-radar environment of northern Canada. The shell incorporates characteristics of an expert system applied to a set of air traffic control decision situations. The report is being studied to determine the direction and scope of future projects.

Contractor

ComEngServ Ltd., Ottawa, Ontario

Report

TP 7576E, An expert system for conflict avoidance: algorithm development — prototype design, CompEngServ Ltd., 1986.

Schedule: September 1985 — March 1986

Funding: TDC — $30,000
DSS — $34,922
Total — $64,922

Project Number: 6546
File Number: D 1455-171
Project Officer: Barry B. Myers

Explosives Detection Technology Assessment

Description

New technology must be applied to the detection of explosives in baggage and on passengers if air travel safety is to be ensured. These technologies must be able to distinguish between dangerous materials and such complex objects as cameras and computers — and they must be able to do so in seconds.

The objective of this project is to identify and evaluate new and emerging technologies that could be applied to explosives detection at airports.

The findings of this study will help Transport Canada to plan research into advanced detection systems.

Progress to June 1986

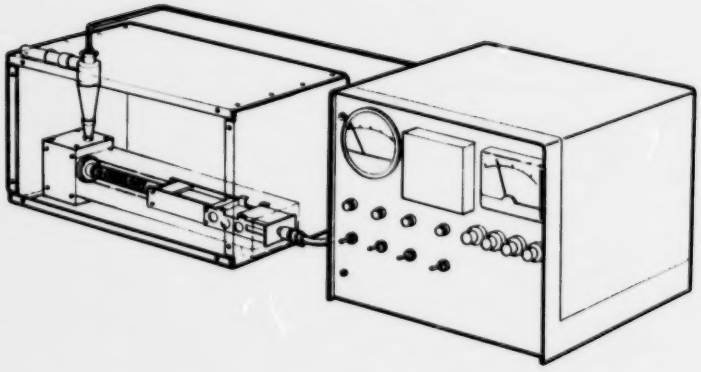
The technology review is underway. A report is scheduled for publication in October 1986.

Contractor

W-Ion Associates, London, Ontario

Report

None to date



Concept drawing of a prototype explosives detector under development by Barringer Research Ltd., of Rexdale, Ontario

Schedule: April 1986 — October 1986
Funding: TDC — $50,552

Project Number: 6821
File Number: D 1455-173-3
Project Officer: Magdi Tewfik

Automatic X-Ray Screening for Carry-on Baggage

Description

The effectiveness of X-ray machines used at airports to examine carry-on baggage for weapons and explosives depends largely on the vigilance of human operators. The objective of this project is to study the feasibility of designing and using an automated system of screening carry-on baggage.

The system will marry current X-ray technology with techniques for computerized pattern detection. Researchers will design, develop and demonstrate an operating model using hardware and equipment provided by the electronics laboratory of the National Research Council. The goal is to build a test model capable of detecting a variety of potentially dangerous objects, and sounding an alarm within three seconds.

In addition to improving detection efficiency, an automated system could save Canadian airport operators up to $1.5 million annually through reductions in operating personnel.

Progress to June 1986

Initial pattern recognition software has been developed. The software is being married to an expert system to enhance the overall capability of the software to detect dangerous goods.

Contractor

Roy Ball Associates Ltd., Ottawa, Ontario

Report

None to date

Schedule: August 1985 — September 1986

Funding: TDC —	$100,000
DSS —	$175,000
Total —	$275,000

Project Number: 6380
File Number: D 1455-168
Project Officer: Barry B. Myers

Airport Pedestrian Flow Model

Description

When airport terminals become clogged with passengers, efficiency drops and service deteriorates. This congestion can occur for a variety of reasons, including weather, diverted flights and mechanical failures. At present, the only solution to persistent overcrowding is to expand the terminal. This is a costly solution, and it may not be necessary if pedestrian flow through the airport can be improved to make optimum use of existing facilities.

The objective of this project is to develop a flexible computer graphics program that will allow airport managers to simulate pedestrian traffic flow in terminals. Alternative flow patterns can then be explored and changes tailored to levels of congestion. The tool can also be used in planning airport expansions and in training new managers.

In developing the program, the contractor will make use of the data gathered by existing simulation models that analyze the loading of air terminal building subsystems and gates.

The program will use a split screen to display terminal layout, time, aircraft arrival and departure information, and a menu of commands to control the model. It will be developed on an IBM XT computer and utilize an enhanced graphics adapter and an enhanced colour display monitor.

Progress to June 1986

A program model has been developed that includes four modules: a command module controls the software/user interface and facilitates input of data and control of output; a terminal layout module defines the floor plan; a traffic flow simulation module produces the pedestrian traffic flow data; and, the graphics module produces an animated graphic display of the flow.

Contractor

IMC Management Consultants Inc., Edmonton, Alberta

Report

Draft, Airport graphics simulation model, IMC Management Consultants Inc.

Split-screen format provides graphic display and tabulated or graphic presentations of pedestrian flow in the terminal.

Schedule: January 1986 — June 1986

Funding: TDC —	$40,000
EDA —	$20,000
Total —	$60,000

Project Number: 6552
File Number: D 1455-172
Project Officer: Brian Marshall

Voice Advisory Information System for Helicopters

Description

Helicopters are frequently used to lift heavy loads at logging and construction sites and on rescue operations. Flight operations are critical during heavy lifting, yet the delicacy of much construction and rescue work requires that pilots focus their attention on activities outside the cockpit rather than on the cockpit instruments.

To relieve pilots of the need to look at their instruments, the contractor has proposed a concept for a voice advisory information system (VADIS). The computerized system would automatically inform pilots about cockpit conditions through verbal messages generated by a voice synthesizer.

The objective of this project is to design, manufacture and flight-test VADIS.

Use of VADIS would not only make helicopter operations safer, but would also reduce operational maintenance costs. Pilots using VADIS would be better able to avoid overloading and overstressing their aircraft, two factors that contribute to the current high maintenance costs for helicopters employed for heavy lifting.

Progress to June 1986

Three prototype VADIS have been designed and built. These systems will be flight-tested on Canadian Coast Guard helicopters.

Contractor

Northern Airborne Technology Ltd., Prince George, British Columbia

Report

Draft, Development of a prototype of a helicopter voice advisory system: VADIS, Northern Airborne Technology Ltd.

VADIS permits helicopter pilots to focus their attention on the mechanics of a lift without endangering their aircraft.

Schedule: January 1985 — July 1986
Funding: TDC — $57,483

Project Number: 6347
File Number: D 1455-159-2
Project Officer: Micha Avni

Smoke Mask Criteria

Description

Although air passenger safety technology has advanced significantly in the past decades, incremental increases in levels of safety under specific conditions are always possible. One area where improvements can be made is in protecting passengers from the smoke and toxic gases produced by on-board fires.

This project has three objectives: to produce criteria for suitable airline passenger masks; to determine if an existing mask meets these criteria; and, to indicate the direction for subsequent development.

Progress to June 1986

The project is complete. The researchers discovered limitations in both the performance criteria they developed and in the function of several existing smoke masks. The most prevalent problem was leakage of exterior air into the mask, due to minor design faults or improper wearing. The findings of this work are under review by Transport Canada.

Contractor

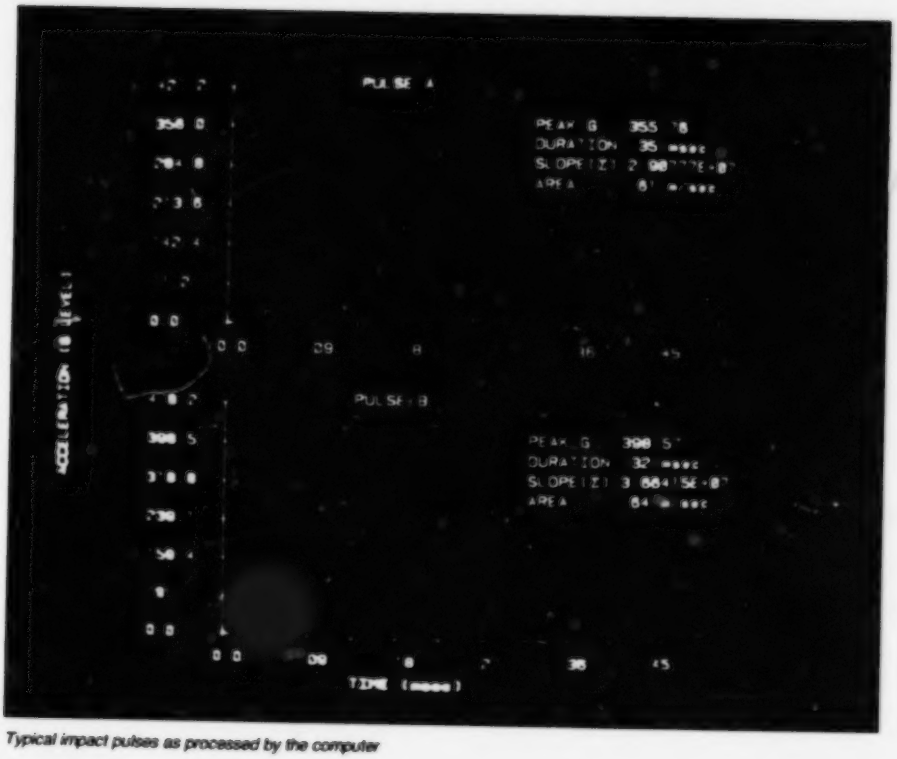
Ontario Research Foundation, Mississauga, Ontario

Report

Draft, Airline passenger protective breathing equipment study, Ontario Research Foundation.

Schedule: August 1984 — March 1986
Funding: TDC — $89,400

Project Number: 6206
File Number: D 1455-162
Project Officer: Jacques E. Laframboise



Typical impact pulses as processed by the computer

Instrument Impact Analysis

Description

Aircraft accident investigators analyze the filaments of light bulbs in a plane's failure warning lights to infer the state of electrical circuits at the moment of impact. Determining whether the lamp was on or off helps investigators to pinpoint system failures. Flight conditions are also inferred by certain flight instruments, but the technology available to investigators for this aspect of their work is much less sophisticated than for light bulb analysis.

The objective of this project is to develop a manual that will help investigators determine an instrument's reading at the moment of impact. The manual will outline the impact parameters necessary to cause damage in instruments.

In support of this work, TDC has funded a research program to study and test theories relating to component resonances under shock loading. This work will include physical testing of instruments under controlled crash conditions and a physical analysis of the results.

Progress to June 1985

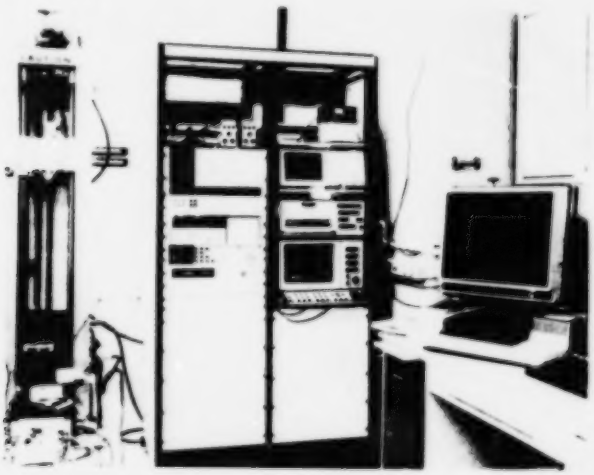
Computer-controlled impact test equipment has been developed and the necessary software written. A flight instrument tester has been designed to test Pitot-static instruments from crashed aircraft. Data gathering on instrument impact dynamics continues.

Contractor

Michael Poole Consultant, Gloucester, Ontario

Report

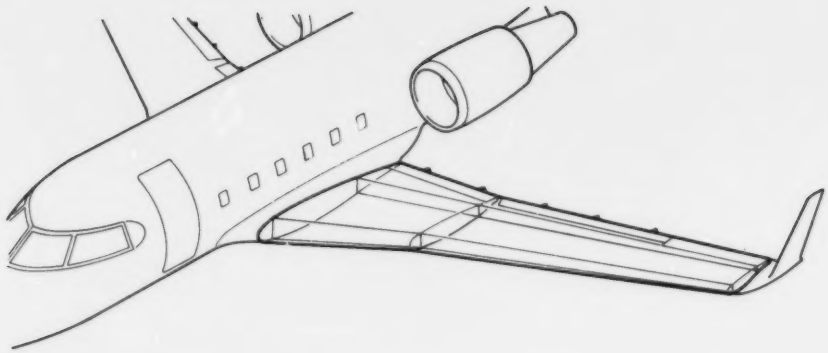
Draft, Instrument impact dynamics study (in support of aircraft accident investigation), Michael Poole Consultant.

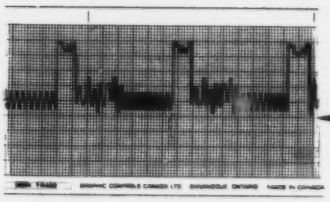


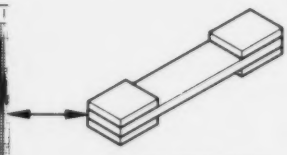
Impact test machine (far left) and related instrumentation

Schedule: July 1985 — July 1986
Funding: TDC — $43,614

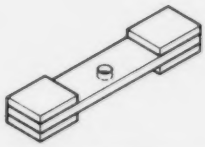
Project Number: 6485
File Number: D 1455-129-3
Project Officer: Barry B. Myers



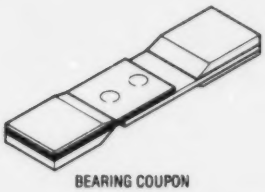




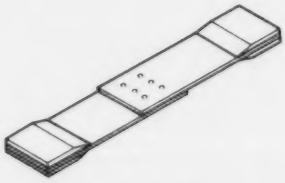
TENSION, COMPRESSION COUPONS – FATIGUE



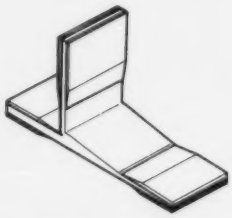
TENSION, COMPRESSION COUPONS



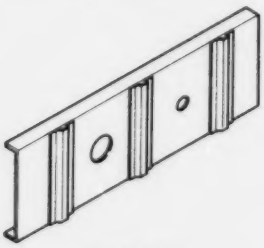
BEARING COUPON



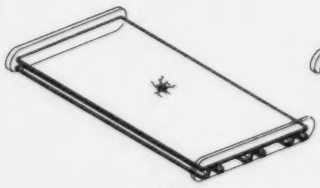
BOLTED SPLICE



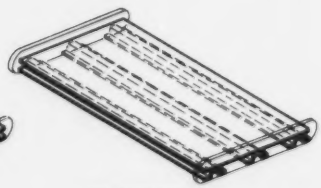
SKIN-SPAR INTERFACE COCURED



SPAR ELEMENT



IMPACT DAMAGE



COMPRESSION COVER ELEMENT

Advanced composite wing details

Advanced Composite Wing Design

Description

In 1977 TDC commissioned Canadair to study the impact that new technology could have on the fuel efficiency of small transport aircraft. The results showed that fuel efficiency could be increased 20 to 40 per cent over ten years. To confirm the results, TDC sponsored a program of detailed analytical and experimental work devoted largely to engine installation and wing configurations.

The results of the program indicated that a 12 per cent increase in energy efficiency could be achieved by using lighter composite materials in primary aircraft structures. This finding and others were embodied in a preliminary design for a fuel-efficient transport aircraft.

The objective of this project is to design, build and test a wing structure which uses composite materials, but which is based on conventional wing design for fuel-efficient transport aircraft. The major challenges lie in developing a damage-tolerant design and in ensuring that assembled structures can be reliably inspected for manufacturing flaws and operational damage.

This project will give the Canadian aerospace industry the knowledge and skills in the application of composite materials necessary to remain competitive globally.

Progress to June 1986

The baseline structure is a swept wing, featuring an advanced airfoil and an aspect ratio of 10:31. Preliminary designs have been completed for a two-spar, multi-rib, wing box configuration. The design uses double "z" stiffened wing covers, metal and composite ribs, and channel-type front and rear spars. The graphite/epoxy composite system selected for the wing covers is a second-generation material, Narmco 5245 resin with Hercules IM6 fibres. The preliminary design stage has been completed. Fabrication and testing of small components is in progress.

Contractor

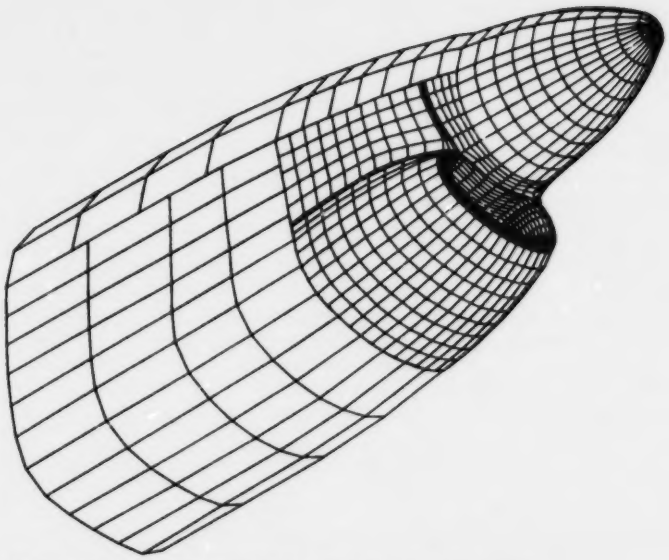
National Research Council, Ottawa, Ontario

Report

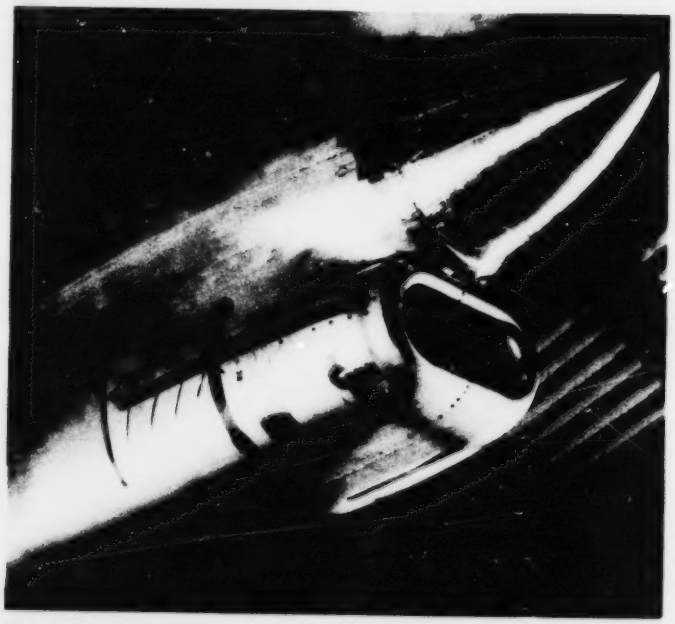
None to date

Schedule: October 1983 — September 1986
Funding: TDC — $250,000

Project Number: 6099
File Number: D 1455-142
Project Officer: Barry B. Myers



Computer models are used extensively in the nacelle research program.



DHC experimental nacelle

Nacelle Airflow Optimization

Description

The cost of fuel is an important factor in the viability of short-haul freight and commuter air services. Fuel-efficient turboprop engines are most frequently used on aircraft serving these markets, but incremental improvements in aircraft performance and efficiency are still possible.

Improved nacelle design offers the possibility of reducing airframe drag, increasing propeller efficiency and lowering dynamic losses in the engine's air intake. In the past, changing nacelle design has required costly, time-consuming wind tunnel tests. However, a computer model called VSAERO is now available to predict the three-dimensional air flow around a nacelle and into an engine intake.

The objective of this project is to develop confidence in VSAERO among Canadian manufacturers, by using the computer model to design an optimized propeller/engine/nacelle combination, and then verifying the results through wind tunnel tests.

VSAERO is being applied to a nacelle design similar to de Havilland's DHC-6 nacelle, in combination with an engine similar to the Pratt & Whitney PW124 engine. Two configurations of the nacelle will be explored: an existing DHC-6 nacelle design with a scoop intake, and a new nacelle with a Pitot intake.

The project sets a precedent in that two major Canadian aerospace manufacturers are collaborating in a joint research program. Both manufacturers stand to benefit from the program through improved product performance.

Progress to June 1986

VSAERO has been used to analyze air flows around each of the configurations. Test models have been constructed and the first set of wind tunnel tests has been completed.

Contractors

Pratt & Whitney Canada Inc., Longueuil, Quebec
de Havilland Aircraft of Canada Ltd., Downsview, Ontario

Report

None to date

Schedule: October 1984 — July 1986

Funding: TDC —	$290,200
EMR-Energy R&D Program —	$204,653
Total —	$494,853

Project Numbers: 6144, 6166
File Number: D 1455-112-9
Project Officer: Barry B. Myers

Fuel-Efficient STOL Aircraft

Description

In 1977, de Havilland Aircraft of Canada Ltd. conducted a parametric study which showed that new technology could significantly improve the fuel efficiency of short take-off and landing (STOL) aircraft. This finding led to the creation of a four-phase research program to establish a data base for the design of a fuel-efficient STOL aircraft.

During initial phases of this program, researchers designed and tested a slotted aileron with a 14 per cent thickness/chord airfoil incorporating a leading-edge slot to improve maximum lift and control. The test results indicated that use of this aileron design could allow significant reductions in the size of wings and the size and complexity of flap systems or ailerons.

Researchers also designed and tested a new propeller-tip airfoil of 4 per cent thickness/chord. Its extensive laminar flow and low shock losses were found to reduce low drag.

The current, fourth phase of this program is aimed at increasing the fuel efficiency and reducing the operating costs of STOL aircraft.

Progress to June 1986

Researchers conducted design studies of 19-, 36-, and 50-passenger aircraft capable of a Mach 0.7 cruising speed. The overall sizing of the wings and empennage of each aircraft is complete. Comparisons of energy efficiency, operating costs and sensitivity to technical improvement are now underway.

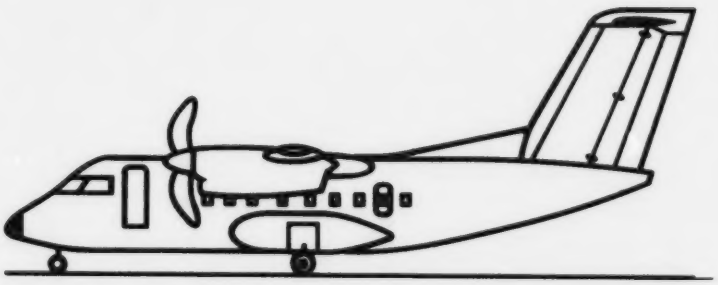
A slotted aileron model, incorporating a new inverse design method for slotted airfoils, was fabricated. The model was tested in the National Aeronautical Establishment's two-dimensional wind tunnel with satisfactory results. Work on the full-scale aileron has started. Further tunnel testing is scheduled for March 1987.

Contractor

de Havilland Aircraft of Canada Ltd., Downsview, Ontario

Report

None to date



50-passenger STOL aircraft featuring five abreast seating and prop fan propulsion

Schedule: September 1984 — May 1987

Funding: TDC —	$185,218
EMR-Energy R&D Program —	$200,000
Total —	$385,218

Project Number: 6210
File Number: D 1455-112-6
Project Officer: Barry B. Myers

MARINE TECHNOLOGY

Marine Technology

Canada's unique marine environment provides ample R&D challenges to develop technology specially tailored to operations in ice-covered waters. While the focus of TDC's marine technology R&D program continues to be design, regulation and safe operation of ice-transiting vessels, the program also addresses the safety and efficiency of navigation in more temperate latitudes.

Arctic Navigation Support Systems

The key to safe navigation in the north is timely and effective detection and avoidance of icebergs and other ice hazards. TDC has underway several research projects aimed at developing Arctic navigation support systems. These include:

- developing remote ice-sensing devices. Current work features ice sensors based on: airborne synthetic aperture radar (SAR), shipboard ice-sensing radar, sonar and helicopter ice-thickness sensors;
- integrating ice data and environmental data and developing display and imagery technologies for use on the bridge of the ship during ice-transiting operations; and
- providing scientific data, scenario and human factor information for use in the development of ice-transiting marine training and research simulators.

Ice-Transiting Ship Technologies

TDC is supporting research in a number of areas to contribute towards a safe and efficient year-round navigation capability in Arctic waters. This research is aimed at:

- providing a scientific basis for design and operating criteria applicable to regulations governing navigation in Arctic waters;
- fostering the development of improved marine vehicles — such as the next-generation commercial Arctic carriers — and related hull, propulsion and auxiliary systems technologies; and
- developing ice tank scaling and modelling techniques.

General Marine Research

TDC is committed to advancing the performance capabilities of government and commercial vessels and marine structures operating in the more southern latitudes, including the east and west coasts, the Great Lakes and the St. Lawrence River.

To this end, TDC is studying: the effect of ice loads on fishing vessels, the feasibility of SWATH ships, the dynamic stability of various small vessel designs and fibre-optic technology in marine systems.

TDC is also involved with general marine technology research and supports projects that range from studying aluminum welding techniques, to developing technology to assist in rescue operations and to permit safer transfer of loads between ships at sea.

In-Air Acoustic Detection of Icebergs

Description

Fragments of icebergs hidden in pack sea-ice present a serious hazard to shipping. Yet ships have no way of reliably detecting these fragments, and so must proceed with extreme caution in ice-infested waters.

A new method of detection based on in-air acoustic technology (SODAR) has been developed in the United States. The objective of this project is to evaluate the feasibility of using SODAR aboard ships for iceberg detection.

Researchers will devise a variety of land-based tests for SODAR, incorporating environments that replicate the noise levels and temperatures found aboard working icebreakers and icebreaking tankers. During these tests, the geometry of the SODAR device and the detected object will be made to coincide with possible locations for SODAR equipment aboard ships.

The results of these tests will be used to establish the optimum parameters for a shipborne iceberg detection instrument, and to prepare operating procedures for SODAR. The decision to test SODAR in the Arctic will be based on the findings of the project.

Progress to June 1986

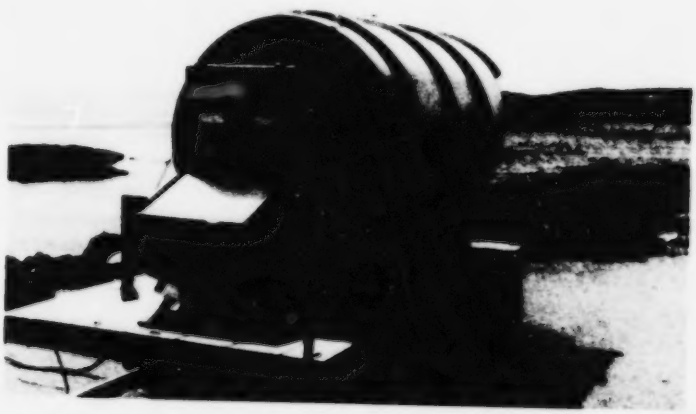
The SODAR equipment has been rented for the tests and overland testing completed. The experience gained from these tests is being used to develop tests over sea-water from a land base.

Contractor

Arctic Sciences Ltd., Sidney, British Columbia

Report

None to date



Sounder used for initial overland tests of SODAR

Schedule: June 1985 — November 1986

Funding: TDC —	$ 40,000
DSS —	$105,000
CCG —	$ 20,000
DFO —	$ 5,000
Total —	$170,000

Project Number: 6419
File Number: D 1460-224
Project Officer: Howard Posluns

Sonar Detection of Icebergs: An Assessment

Description

Since 1980, TDC has been developing navigation systems to help ships detect ice hazards. Many technologies are being considered. In 1984, field tests aboard the MV *Arctic* confirmed the feasibility of using sonar to detect icebergs. However, researchers still have to develop a way of estimating the size of icebergs based on sonar echoes.

The objective of this project is to acquire additional technical input on the operational application of sonar to iceberg detection. Researchers will gather data by conducting further field tests using the *Arctic*.

Researchers will use the results of this project and previous studies to evaluate the potential of sonar for iceberg detection. If the technology is practical, a system specification for a sonar device will be developed.

Progress to June 1986

Data were gathered aboard the *Arctic* during the vessel's Arctic voyage in May/June 1986. The data are now being analyzed.

Contractor

Canarctic Shipping Co. Ltd., Ottawa, Ontario

Report

None to date

Schedule: March 1986 — September 1986

Funding: TDC —	$ 85,000
EMR-Energy R&D Program —	$130,000
Total —	$215,000

Project Number: 6564
File Number: D 1460-195-3
Project Officer: Howard Posluns

Ultrasonic Doppler Velocimeter for Icebreakers

Description

Icebreaking operations would be quicker, more efficient and more economical if the precise speed of the ship in relation to the ice surface were known. This information is not provided by current shipboard equipment. Advances have been made in Doppler radar technology, but there are no commercial velocimeters capable of accurately measuring speeds under one kilometre per hour. Another drawback is that this radar operates in the gigahertz frequency range and is sensitive to parasitic reflections from level or wet surfaces, making it unsuitable for icebreakers, which require precise readings at extremely low speeds. An investigation of an ultrasonic device was pursued in order to overcome these problems.

Progress to June 1986

Researchers designed, constructed and tested a laboratory model of an ultrasonic Doppler velocimeter. The unit operated in the lower ambient noise frequency band to minimize the effect of the noisy environment aboard an operational icebreaker. Satisfactory results from the tests were followed by the construction of a prototype.

Limited tests of the prototype uncovered problems caused by the low power rating of the ultrasonic transducer. Follow-on investigations by TDC led to the identification of a new transducer supplier. Negotiations are currently underway for development of a velocimeter with a more powerful transducer.

Contractor

Gentec Inc., Ste-Foy, Quebec

Report

TP 6786E, Ultrasonic Doppler velocimeter for icebreakers, Gentec Inc., 1985.

Schedule: February 1983 — June 1985
Funding : EMR-Energy R&D Program — $240,000
DSS — $ 68,640
Total — $308,640

Project Number: 4774
File Number: D 1460-188
Project Officer: Roy S. Nishizaki

Evaluation of Ice Thickness Sensors

Description

Since 1980, TDC has sponsored a program to develop and evaluate a synthetic pulse radar for remote sea-ice thickness measurement. Two other measurement systems have been developed that use different technologies: the Instrumar impulse radar system and the Geotech electro-magnetic induction system.

The objective of this project is to evaluate and compare the three systems by testing them in the field. The results of this study will indicate a direction for future development work.

Initial shake-down trials will be conducted in southern Canada to correct any operational or logistical problems arising from the trial procedures. The actual field trials will be conducted in the Arctic. Successful implementation of an all-weather, airborne instrument to measure the thickness of sea-ice would facilitate navigation, extend the shipping season and improve ship safety. The instrument would be a valuable asset to the Canadian Coast Guard.

Progress to June 1986

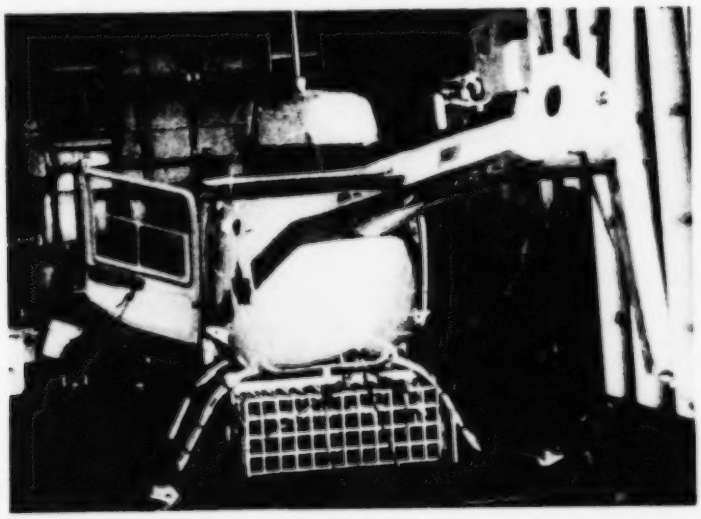
A preliminary assessment of the three technologies has been completed.

Contractor

Canpolar Consultants Ltd., Toronto, Ontario

Report

None to date

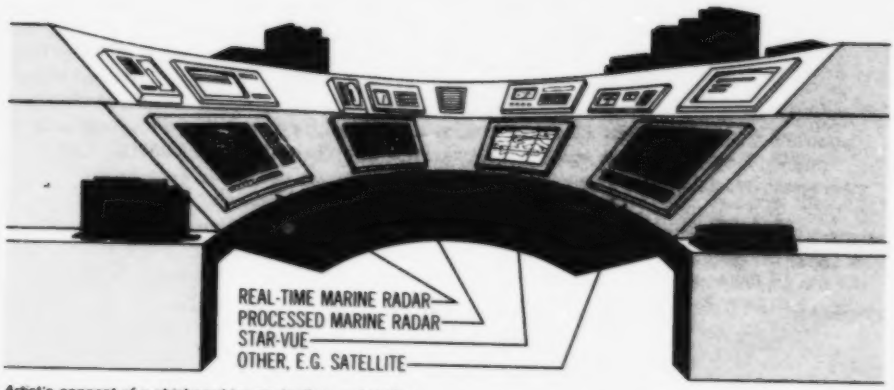


The antenna for the synthetic pulse radar is mounted in a cage between the struts of a helicopter.

Schedule: January 1986 — November 1986

Funding: TDC —	$177,000
DFO —	$ 40,000
Total —	$217,000

Project Number: 6606
File Number: D 1460-230-1
Project Officer: Howard Posluns



Artist's concept of a shipboard ice navigation workstation

Ice Navigation Workstation Development

Description

Marine transportation continues to offer the most effective means of moving Arctic resources to world markets. For this reason, commercial shipping in the North is growing, despite the difficulties and hazards of operating vessels in ice-infested waters. Improved systems for navigating in ice are urgently required.

TDC has been supporting the development of a multi-task ice-data analysis system called MIDAS. The system is designed to provide ships with realistic video images of ice formations, thereby facilitating better route planning. The MIDAS concept includes:

- STAR-VUE, a synthetic aperture radar downlink receiver and softcopy display system that automatically receives, stores and interactively displays airborne radar data;
- MARINE-VUE, which displays real-time and processed radar images relayed from one or more marine radar systems;
- a system to receive conventional ice and weather charts and real-time satellite imagery; and,
- a protocol for communication among the systems. At present this is done by the operator.

MIDAS has now evolved into a concept for an integrated, shipborne workstation called NAV-ICE. NAV-ICE requires that both the airborne and the marine radar data be displayed on bright video-type screens on the bridge of a ship. The scale and the orientation of the data must be approximately the same for ease of utilization.

The objective of the current project is to further develop the NAV-ICE concept by upgrading and evaluating STAR-VUE and MARINE-VUE.

Progress to June 1986

To make STAR-VUE more suited to ship navigation, additional functions were added to the system: it can now incorporate range and bearing information, record the ship's track on the system's imagery and allows for operator-selected waypoints. Researchers also evaluated STAR-VUE from an ergonomical perspective.

MARINE-VUE evolved from a radar image display system originally intended for use on drill ships. The system was modified to reduce the time delay in presenting its processed radar imagery. This will make the system more useful aboard a moving ship.

An advanced prototype NAV-ICE system was designed, built and tested aboard the MV *Arctic*. Familiarization courses were given to the *Arctic* crew on the operation of the system. Field tests are planned for June 1986.

Contractor

Intera Technologies Ltd., Calgary, Alberta

Report

None to date

Schedule: September 1985 — September 1986

Funding: TDC —	$ 31,000
EMR-Energy R&D Program —	$277,000
TDC-AAMP —	$ 92,833
Total —	$400,833

Project Number: 6531
File Number: D 1450-17-1
Project Officer: Howard Posluns

Human Factors Research: Arctic Ship Safety

Description

As the equipment used for ship navigation becomes more complicated, designers are realizing that more attention must be paid to the human factor. Ergonomics — the study of the efficiency of people in their working environment — is becoming increasingly crucial in the design and selection of new shipping technology. Ultimately, the safety of ships at sea depends on adequate links with the human operator.

The objective of this project is to determine the feasibility of quantifying the relationship between human factors and ship safety in Arctic waters during critical navigation incidents. The data will be presented in a format that is suitable for use in the risk assessment models used by the Canadian Coast Guard to establish Arctic navigation regulations.

The results of this work will provide an insight into what types of technologies might reduce operator uncertainty in hazardous conditions. Appropriate research and development activities could then be undertaken.

Progress to June 1986

Researchers gathered data and observed operations aboard an icebreaker during the 1985 Arctic shipping season. They later matched critical piloting incidents with navigational, environmental and operational data to determine causal relationships. The researchers concluded that it is feasible to quantify operator performance for the purpose of risk assessment. Ice regime definitions are being developed.

Contractor

Polar Sea Research Ltd., Lethbridge, Alberta

Report

Draft, Measurement of operator performance and Arctic ship safety: feasibility study, Polar Sea Research Ltd.

Schedule: April 1985 — July 1986

Funding:	
TDC —	$29,116
CCG —	$15,000
Total —	$44,116

Project Number: 6535
File Number: D 1460-145-11
Project Officer: Ian M. Bayly

MV *Arctic* Testing Program: Spring 1986 Voyage

Description

The MV *Arctic* is a 28,000 dwt Ice Class II bulk carrier. Launched in 1976, the vessel has been used, in part, as a floating laboratory under a joint government/industry scientific program. The vessel was instrumented extensively to collect technical and operational data over several Arctic shipping seasons. The findings have been used to improve the design, performance and safety of ice-transiting ships.

During winter 1985-86, a new bow was fitted to the vessel as part of an ice-class upgrading. Models of the new bow shape had previously been tested in three separate model basins, with the results predicting improved ice-transiting performance.

The objective of this project is to evaluate and verify the predicted improvements in ice-transiting performance through full-scale tests.

Open-water and ice-transiting tests will be correlated directly to the model tests. Additional open-water, ice-transiting and manoeuvring tests will be conducted to compare the new bow with previous full-scale tests of the old bow.

The results of this work will improve understanding of the scaling factors for Arctic cargo carriers.

Progress to June 1986

The tests began in May 1986 with the MV *Arctic*'s first voyage to the Arctic port of Nanisivik.

Contractor

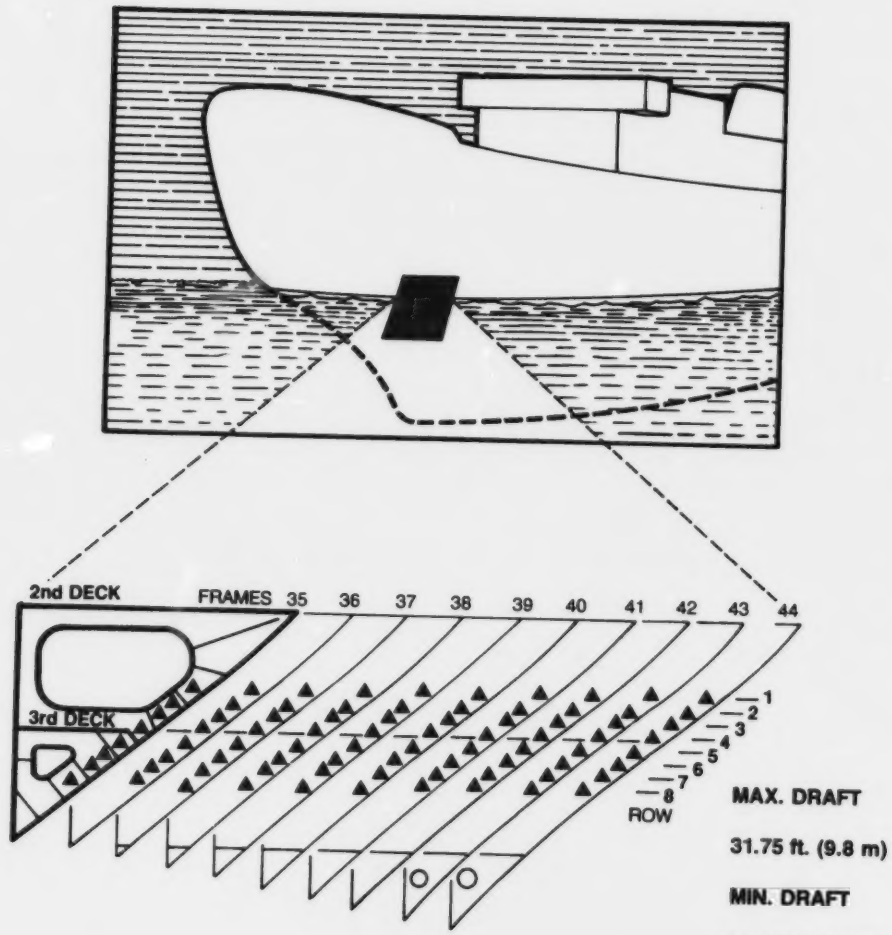
Canarctic Shipping Co. Ltd., Ottawa, Ontario

Report

None to date

Schedule: March 1986 — October 1986
Funding: TDC-AAMP — $305,500

Project Number: 6671
File Number: D 1450-166-46
Project Officer: C. Nowicki



This 12-m² panel in the hull of the Polar Sea *was specially instrumented to measure ice pressures.*

USCGC Polar Class Program 1985/86

Description

Since the late 1970s, the U.S. Coast Guard icebreaking vessels *Polar Sea* and *Polar Star* have been used to gather data in Arctic waters. The program, sponsored by the U.S. Maritime Administration and supported by oil companies, is aimed at increasing marine access to Arctic resources without endangering human life or the environment. TDC's participation in this program began in 1981.

Each year specific research projects are defined and a series of voyages is undertaken. The data collected during these voyages are analyzed and the results are published for use by designers and operators of marine transportation systems and offshore structures.

Two projects were carried out during the 1985/86 season. The first was an expedition in summer 1985 to multi-year ice in the Alaskan Beaufort Sea, to carry out global ice impact load tests. The second was an expedition in January 1986 to McMurdo Sound, Antarctica, to measure ice manoeuvring performance in level ice.

Progress to June 1986

The global ice force impact data collected in the Beaufort Sea were analyzed using software associated with the global load measurement tests conducted previously on the MV *Canmar Kigoriak*. The results contributed to the data base being developed to establish design and regulatory criteria for Arctic ships.

Unusually heavy ice conditions in McMurdo Sound and operational commitments of the vessel prevented effective data collection on ice manoeuvring performance. Draft reports of both projects are under review.

Contractor

Arctec Canada Ltd., Kanata, Ontario

Report

None to date

Schedule: September 1985 — September 1986

Funding: TDC — $100,000
CCG — $100,000
Total — $200,000

Project Number: 6481
File Number: D 1460-181-2
Project Officer: Ian M. Bayly

Arctic Ship Technology

Description

In 1977 TDC supported a review of the technology base for shipping in Arctic waters. This work permitted ship operators and research and development establishments to focus their activities, thereby enhancing Canada's lead in Arctic navigation. More than 1,000 reports on new technology appeared between 1980 and 1984 alone. This great increase in the knowledge base has made necessary another review to encourage a refocusing of R&D activities.

The objective of this study is to identify gaps in the knowledge base for shipping operations. To achieve this, the contractor will: develop probable scenarios for Arctic shipping to the year 2000; review the latest technology in the light of the scenarios; identify knowledge gaps that would inhibit follow-through on scenarios described; and, develop a research plan to fill the gaps.

The contractor will document the results of this study in a format suitable for rapid dissemination to the Canadian interests best qualified to use it.

Progress to June 1986

An interim report describing in detail the present and potential Arctic activities in the areas of mineral, oil and gas exploration has been written. Probable Arctic shipping scenarios and technology requirements are being drawn.

Contractor

Melville Shipping Ltd., Calgary, Alberta

Report

None to date

The MV Arctic, a commercial cargo vessel operating in the Arctic

Schedule: October 1985 — October 1986

Funding: TDC —	$167,155
TDC-AAMP -	$100,000
EMR-Energy R&D Program —	$100,000
Total —	$367,155

Project Number: 6555
File Number: D 1460-227
Project Officer: Jacques E. Laframboise

Icebreaker Bow Development

Description

The ability of an icebreaker bow to rupture an ice cover is of prime importance to the design, cost, power requirements and displacement of an ice-transiting ship.

The objective of this project is to formulate icebreaking bow performance criteria for use in the development of a computerized bow optimization model for ship designers.

The research will be based on a model developed by Dr. Carter in a previous project supported by TDC. This model optimizes icebreaking bow performance by relating ship resistance to the effective ice rupture force applied by the bow of the ship.

The refined model will be used to prepare one or more icebreaker bow concepts for the Canadian Coast Guard ship *Louis St. Laurent*. The concepts will optimize continuous icebreaking at available continuous power and facilitate extraction after ramming.

The model will subsequently be developed into a computer program to help designers evaluate existing bow lines and predict the effects of proposed modifications to a number of Canadian Coast Guard ships.

Progress to June 1986

As a first step in developing the model, a set of bow lines for the *Louis St. Laurent* has been prepared.

Contractor

Dr. Donald Carter, Québec, Quebec

Report

None to date

Louis St. Laurent

Schedule: February 1986 — January 1987

Funding: TDC —	$ 52,000
EMR-Energy R&D Program —	$100,000
Total —	$152,000

Project Number: 6613
File Number: D 1460-177-2
Project Officer: Jacques E. Laframboise

Automated Ice Ramming System Development

Description

The efficiency and effectiveness of an icebreaker is greatly dependent on the speed at which it rams into ice. Studies aboard the MV *Arctic* showed that there was an optimum ramming cycle for the ship. A ram achieved at the ship's optimum impact speed offered a 250 per cent improvement in advance time, compared with poorly executed rams. Such an improvement could benefit Arctic shipping enormously, particularly commercial operations where schedules are important to financial returns.

The technology already exists to provide semi-automatic control of a ship's ramming cycle. The objective of this multi- phase research effort is to develop a ramming automated monitoring system (RAMS).

The RAMS concept design calls for a computerized operating system that receives continuous information from shipboard sensors about the speed and acceleration of the vessel, and such other factors as hull strain. The system will have several operating modes — ramming, continuous icebreaking, etc. — based on performance equations for the ship. The ship's master will select the speed and mode, depending on ice conditions, and RAMS will automatically operate the ship.

Progress to June 1986

In the first phase of the RAMS development, researchers defined the system hardware. It consists of: sensors to measure ship operating conditions and ice impact forces; data acquisition subsystems; display and control console; and, an actuator subsystem that acts as an interface between the control computer and the ship's engine controls. A computer simulation study was made. The simulation program emulates the performance of the planned system using the propulsion system and ice-transiting characteristics of the MV *Arctic* as a model.

Contractor

Melville Shipping Ltd., Calgary, Alberta

Report

Not releasable at this time

Schedule: October 1985 — January 1986

Funding: TDC — $14,878
TDC-AAMP — $15,000
DSS — $45,000
Total — $74,878

Project Number: 6510
File Number: D 1460-166-145
Project Officer: Howard Posluns

Segmented Model Ice Tests: Phase 2

Description

Icebreaking involves several complex inter-related mechanisms and processes. It has been hypothesized that different mechanisms predominate over the bow surface area as force angles change. Each contributes individually to ice resistance and icebreaking forces. To date, however, only the sum of all forces has been effectively measured in model tests. Individual forces have not yet been measured.

In the previous phase of this two-part project, the contractor developed a new technique for testing models of icebreakers. The technique allowed researchers to measure the components of the total force contributed by different areas of the bow. A model of the *Pierre Radisson* was built with one side of the forebody waterline area incorporating three independent segments of hull surface. Each segment was instrumented to measure the normal and frictional ice forces acting on that segment.

Tests showed that the segmented testing technique can measure ice force location and magnitude. However, while force location data agreed with analytical projections, there was some difference between expectations based on theoretical work and the magnitudes of ice forces indicated by the model.

The objective of this second phase of the project is to refine the model testing and analysis techniques to achieve precise and reliable measurement of magnitude and location of normal forces and magnitude and direction of friction forces. Researchers will design a special calibration system in an attempt to achieve the desired accuracies.

Progress to June 1986

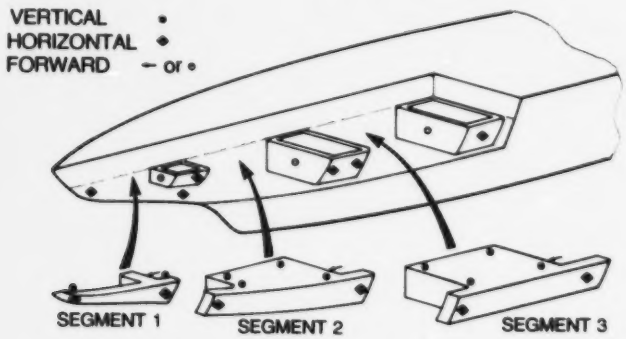
This project has just started.

Contractor

Arctec Canada Ltd., Kanata, Ontario

Report

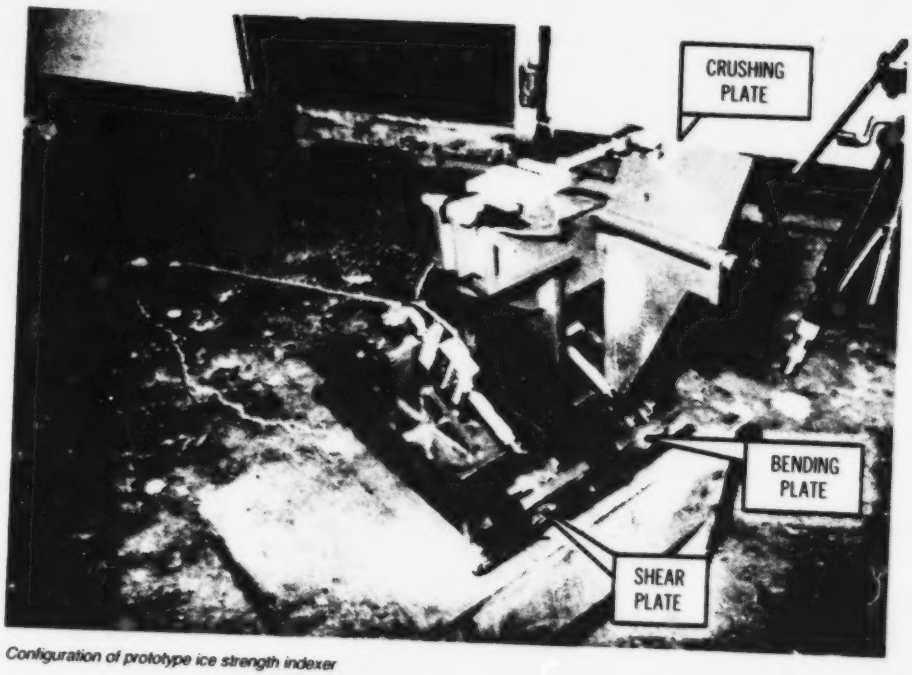
None to date



Model of Pierre Radisson *shows location of hull segments and load cells (main deck omitted).*

Schedule: May 1986 — January 1987
Funding: EMR-Energy R&D Program — $138,000

Project Number: 6640
File Number: D 1460-194
Project Officer: Ian M. Bayly



Configuration of prototype ice strength indexer

Ice Strength Indexer

Description

Models are used to predict how icebreakers will perform under actual sea conditions. Constructing an accurate model, however, requires that the strength characteristics of ice used in the laboratory closely resemble those of sea-ice. Researchers have been able to grow ice in test tanks that reliably reproduces the flexural strength of natural ice. Unfortunately, differences in the properties of model ice and natural ice make it difficult for researchers to correctly reproduce the compressive strength and shear strength of natural ice in the laboratory. The extent of the error in predicting ship performance was made abundantly clear during analysis of the data collected by the MV *Arctic* at sea.

The objective of this project was to develop a device called an ice strength indexer and a correlation procedure to help researchers use model tests to predict more accurately how real ships will perform in natural ice. This development could reduce the costs involved in designing ship hulls.

Progress to June 1986

The project is complete. The prototype indexer measures the flexural, compressive and shear strength of ice. In operation, it will be secured to the test carriage and drawn through the model ice simultaneously with the model of the ship's hull. The indexer features elements that cause the ice to fail in each of three modes: bending, shear and horizontal crushing. Extensive instrumentation collects data on several parameters, including the total resistance of the ice sheet and the force attributable to each of the failure modes.

Contractor

Melville Shipping Ltd., Calgary, Alberta

Report

Draft, An ice strength indexer for model towing tanks, Melville Shipping Ltd.

Schedule: September 1985 — July 1986
Funding: TDC-AAMP — $68,335

Project Number: 6548
File Number: D 1460-226
Project Officer: C. Nowicki

Ice Ridges and Ship Performance

Description

The regulations currently used to decide whether a ship may travel unaccompanied in severe ice conditions evaluate the vessel's performance only in level ice. There is increasing evidence, however, that other performance criteria such as powering, manoeuvring and ice ridge penetration should also be considered. The findings of the MV *Arctic* scientific program, which analyzed ramming cycles, have focussed researchers' attention on ramming and ridge penetration.

The objective of this project is to evaluate the capabilities of various ship designs to penetrate ice ridges, and to establish performance limits for different ship designs in a range of ice conditions.

Researchers will make use of an existing data base representing 15 different ships, tested mostly in the Baltic Sea, and of the results of 40 model tests in the Wartsila laboratories in Finland. They will develop techniques for analyzing ridge penetration and formulae to help ship designers evaluate a vessel's performance limits in ice ridges.

Progress to June 1986

The project has just begun.

Contractor

Wartsila Arctic Inc., Vancouver, British Columbia

Report

None to date

Schedule: May 1986 — December 1986

Funding: TDC —	$ 75,000
DSS —	$ 50,000
Total —	$125,000

Project Number: 6669
File Number: D 1460-234
Project Officer: C. Nowicki

Ice Class Ships: Added Mass Studies

Description

Researchers need to better understand how the performance of an icebreaker during ramming is affected by its added mass, that is, the mass of the water surrounding the vessel. Existing studies of added mass are based on ship vibration in open water and are not applicable to ice. Some exploratory work in the field has been done by Arctec Canada Ltd., using data from the MV *Arctic* trials. However, more analysis is necessary to effectively modify Arctic vessel performance modelling techniques to accurately reflect the effects of added mass.

TDC is supporting two added mass studies. The first will investigate the hydrodynamic added mass phenomenon in ship/ice interaction with reference to recent global load testing with a flexible model of the *Arctic*. The second will develop a calibrated model for evaluating the added mass of a ship ramming first- and multi-year ice.

Both studies will examine information available from full-scale tests, model tests and theoretical analysis. The findings of the studies should permit verification of finite element/analytical modelling work based on an energy balance approach.

Progress to June 1986

Work on these studies has just started.

Contractors

Det Norske Veritas, Calgary, Alberta
Arctec Canada Ltd., Kanata, Ontario

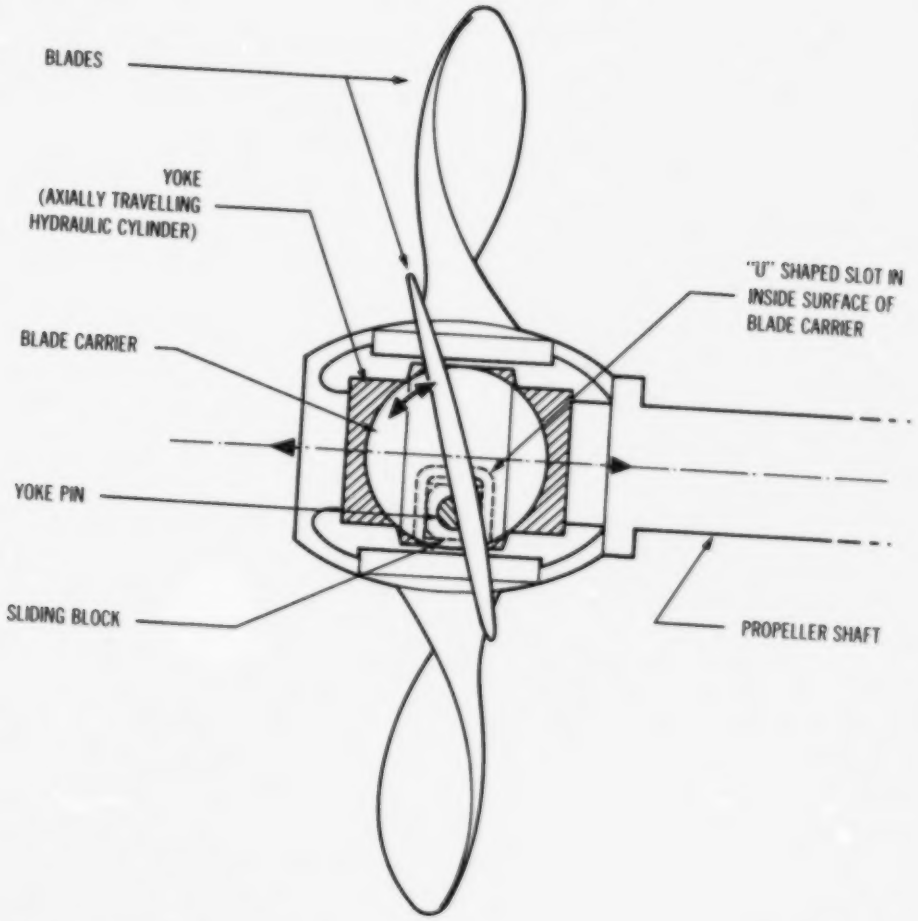
Report

None to date

Schedule: May 1986 — December 1986

Funding: TDC —	$135,000
CCG —	$146,000
DSS —	$141,000
Total —	$422,000

Project Numbers: 6633, 6637
File Numbers: D 1460-231/2
Project Officer: C. Nowicki



Cutaway of propeller illustrating propeller hub mechanism used to measure ice/propeller interaction

Ice Forces on Nozzle Propellers: An Engineering Analysis

Description

During icebreaking, pieces of ice frequently hit a ship's propeller blades, even when the propeller is surrounded by a protective nozzle. To gather full-scale data on how a controllable pitch propeller blade, hub mechanism and propeller shaft are affected by ice, TDC supported an extensive data-gathering program using the icebreaking supply vessel *Robert Lemeur*.

Instruments attached to the hub and blade of a propeller and the ship's stern bearing measured the magnitude and location of ice/blade interaction forces and their effect on the hub and bearing. The data were reduced to engineering quantities for further analysis.

This project has two objectives: first, to use the data from the *Robert Lemeur* and other icebreakers to produce an engineering rationale for the design of ice-worthy propellers, shafts and related drive-train mechanisms; and, second, to recommend appropriate design and regulatory criteria.

Progress to June 1986

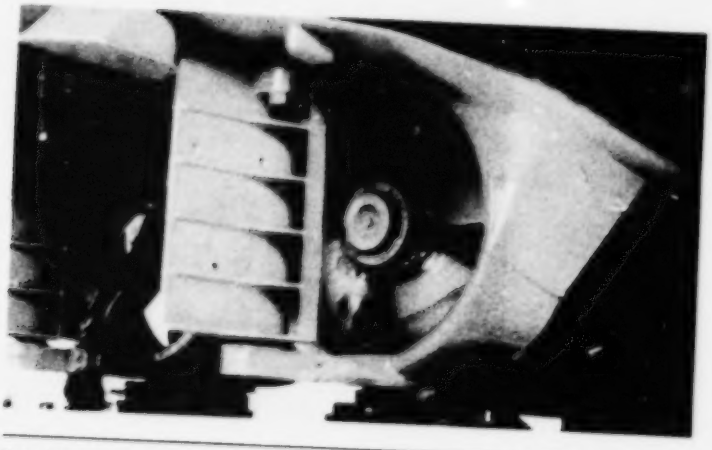
Researchers have defined three models: an ice/blade interaction model based on data from the *Robert Lemeur* and other ships; a blade model that is sufficiently simple to permit easy conversion to design and regulatory criteria; and, a propulsion train model developed by extending an existing shaft model to suit more complex systems. These models are being used to develop recommendations for design and regulatory criteria.

Contractor

Canadian Marine Drilling Ltd., Calgary, Alberta

Report

None to date



Nozzle propeller of the Robert Lemeur

Schedule: August 1985 — July 1986

Funding:	
TDC —	$ 77,983
EMR-Energy R&D Program —	$200,000
Total —	$277,983

Project Number: 6459
File Number: D 1460-156-7
Project Officer: Ian M. Bayly

Protection of Propellers in Ice

Description

Ship propellers can be damaged by ice. Reducing the risk of damage can substantially improve the safety and reliability of ships operating in ice-infested waters.

If an effective method of keeping ice away from propellers could be devised, lighter and more efficient propellers could be used on ships. The ice-screening systems currently in use, however, are prone to clogging with broken ice.

The objective of this project is to determine the most efficient inflow velocities, ice shredding characteristics and propeller designs for various screening configurations.

Progress to June 1986

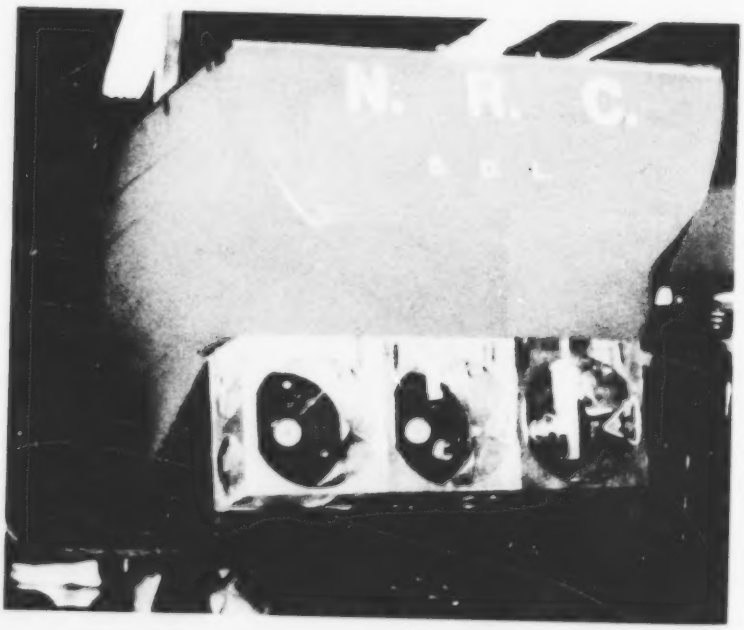
Various conceptual designs were assessed during early phases of the project. Researchers subsequently built a model to study the hull of a proposed 150,000-hp Class 8 icebreaker, incorporating the selected design.

Contractor

W.R. Davis Engineering Ltd., Ottawa, Ontario

Report

None to date



Propeller protection system on hull model

Schedule: February 1983 — August 1986
Funding: TDC-AAMP — $113,821

Project Number: 4949
File Number: D 1460-137-2
Project Officer: N.R. Gore

Ship's Steering Gear Ice Load Modelling

Description

When a ship's steering gear is damaged, the consequences can be catastrophic. Travel in ice-covered waters is particularly hazardous, and icebreaker assistance for crippled ships is expensive. As traffic increases in Canada's northern waters, improved design criteria for steering systems are urgently needed to reduce the risk of malfunction.

This project has two objectives: first, to determine the loads imposed on a ship's steering system by the interaction of ice and rudder; second, to investigate the influence of the ship's draft, its rudder and ice horn design and its propeller rotation on the probability of ice impacts.

The data from this project will add to the body of knowledge already available from earlier research undertaken during the joint U.S. — Canada *Polar Star* expeditions in the early 1980s. The combined results will assist the Canadian Coast Guard's Ship Safety Branch in updating the Arctic Shipping Pollution Prevention Regulations.

Progress to June 1986

Researchers conducted two series of model tests to study the interaction between several different stern and rudder configurations on the one hand, and various kinds of ice formation on the other. Loads on the steering gear were also measured. In total, approximately 130 test data sets were obtained. These are being reduced and analyzed.

Contractor

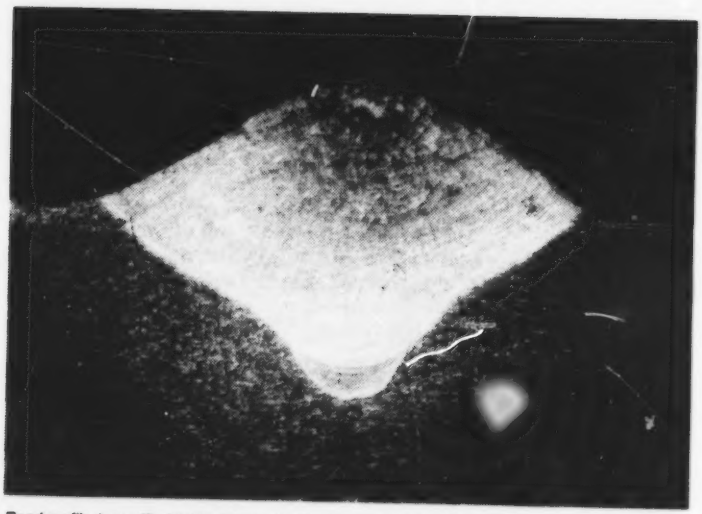
Arctec Canada Ltd., Kanata, Ontario

Report

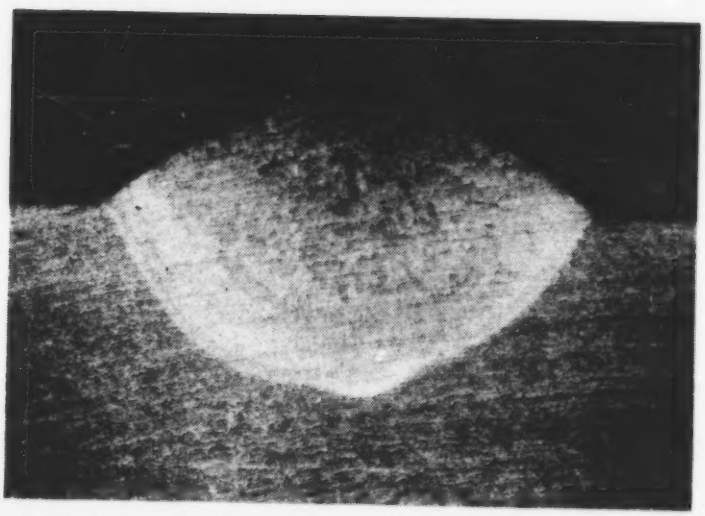
None to date

Schedule: July 1985 — September 1986
Funding: EMR-Energy R&D Program — $160,016

Project Number: 4877
File Number: D 1460-179-2
Project Officer: C. Nowicki



Bead profile (magnified 6.3X) obtained with conventional GMAW process



Bead profile (magnified 6.3X) obtained with the pulsed, frequency-modulated GMAW process

Welding Methods for Aluminum

Description

The difficulty of welding aluminum limits its value as a structural material for some applications. With conventional gas metal arc welding (GMAW), thin sheets of aluminum buckle under intense heat, while weld quality is often inferior in thicker plates.

A major problem of GMAW for aluminum is the nature of the transfer of metal from the electrode wire to the metal being welded, and heat build-up. These problems have been partially overcome by pulsing the current, giving a lower average current. However, the current range over which this pulsing system operates is still very limited and the pulsing frequency is usually fixed at the line frequency, 60 Hz.

The Welding Institute of Canada has tested a variable frequency system for gas metal arc welding on high-strength, low-alloy steels. This frequency-modulated system uses a power-source regulator that can be attached to conventional GMAW machines to provide the necessary pulsing and control.

The objective of this project was to evaluate the applicability of the frequency-modulated gas metal arc welding method to aluminum arc welding. The frequency-modulated equipment was tested on 3-mm thick sheets of aluminum, the type used in lightweight rail cars, and 12-mm thick aluminum plates, the type used in ships. The researchers compared the results of welding with pulsed and conventional techniques. Variables included pulse duration, peak current, wire diameter, background current and wire feed rate. The researchers examined the effect of pulsed welding on the level of distortion and "burn through" in thin sheets and the integrity of the weld on thick plates. Bend testing, traverse tensile testing and hardness evaluations were also done for each weld.

Progress to June 1986

The project is complete. In addition to some of the better known benefits of the pulsed current process, the study found subtle differences between the pulsed and conventional processes. Notably, the pulsed current welding process produced a modified penetration profile and reduced peak weld pool temperature. These effects can have a favourable impact on aluminum fabrication by enhancing the weld pool stability and rendering the welding process more tolerant to variations in operator skill and technique.

Contractor

Welding Institute of Canada, Oakville, Ontario

Report

TP 7432E, Evaluation of pulsed gas metal arc welding of aluminum, Welding Institute of Canada, 1986.

Schedule: March 1984 — March 1986
Funding: ADMM — $142,709

Project Number: 6126
File Number: D 1460-212
Project Officer: Roy S. Nishizaki

Ice Loads on Fishing Vessels

Description

Declining fish stocks and increasing offshore oil drilling are forcing Newfoundland fishermen to venture into areas where floating ice is a major hazard. Existing standards for hull strength in fishing trawlers are proving to be inadequate for the new demands placed on vessels. Many trawlers have sustained hull damage from floating ice. Careful review of the design criteria for small commercial fishing vessels is needed.

In 1983, researchers began defining and collecting the data required to review hull design criteria. A system of measuring the impact of ice on a hull was designed and installed aboard the trawler *Cape Briar*. A number of good readings were obtained in a single trip during the 1983-84 winter season.

The objective of the current project is to finish collecting the data.

Progress to June 1986

The measurement system has been re-installed aboard the *Cape Briar*. Data will be collected during the fall of 1986, and a report of the findings is expected in January 1987.

Contractor

Fisheries Resources Development Ltd., Halifax, Nova Scotia

Report

None to date

The trawler Cape York operating in icing conditions

Schedule: December 1985 — January 1987

Funding: TDC —	$175,433
CCG —	$ 61,000
Total —	$236,433

Project Number: 6600
File Number: D 1460-210
Project Officer: C. Nowicki

Dynamic Stability of Ships

Description

Several research establishments in Canada and other countries are working on understanding the dynamic stability of ships. The Canadian Coast Guard, in cooperation with the Institute of Marine Dynamics of the National Research Council, is undertaking a major study in this field.

The objective of this project is to investigate the effectiveness of ship-motion prediction models to identify ships prone to capsizing. The project was undertaken by TDC at the request of the Canadian Coast Guard, as an adjunct to its longer-term research program.

Progress to June 1986

Several motion prediction computer programs were used to investigate the dynamic stability of two 150-ton fishing vessels, one a hard-chine design, the other a round-bilge design. The capsize behaviour of the two vessels was compared under three combinations of sea condition and vessel speed that are known to be dangerous: subharmonic rolling, resonant rolling and stability loss on a wave crest. The results indicated that the round-bilge vessel was more stable under the first two conditions. Both vessels capsized during prolonged travel on a wave crest.

The researchers concluded that, with further development, the computer simulation programs could provide useful tools to investigate the dynamic stability of vessels.

Contractor

Arctec Canada Ltd., Kanata, Ontario

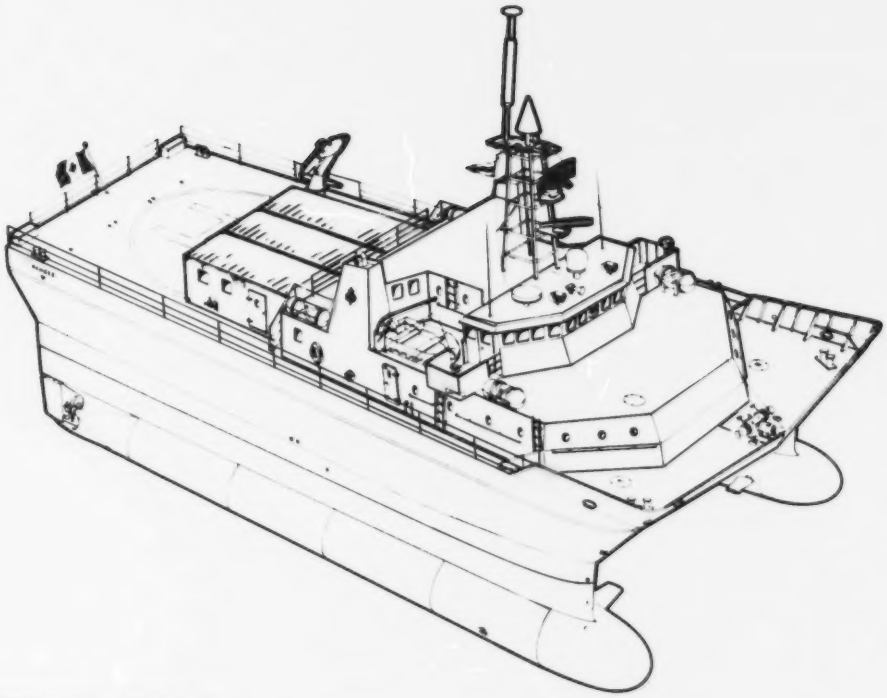
Report

None to date

Schedule: March 1985 — August 1986

Funding: TDC —	$ 68,872
DSS —	$ 55,464
CCG —	$ 35,000
Total —	$159,336

Project Number: 6363
File Number: D 1460-221
Project Officer: N.R. Gore



Artist's concept of SWATH ship

SWATH Ships: Feasibility Study

Description

The waves formed by a ship's hull interfere with its progress by creating drag. Thus, the efficiency of a ship could be significantly improved if more of its hull were below the surface of the water. This knowledge has led to various concepts for new cargo ships, ranging from a pure submarine to a semi-submersible. To ensure stability, twin-hull versions of the semi-submersible, with a platform deck joining the two hulls, have been conceived. The submerged bodies would be far enough under water to minimize displacement wave drag. The struts, or sidewalls supporting the platform deck, would be narrow to minimize wave drag and reduce wave response in high seas. This concept has become known as the Small Waterplane Area Twin Hull (SWATH) ship.

The objective of this project is to evaluate the feasibility of operating SWATH ships on the Canadian east coast, where rough seas are common.

Progress to June 1986

The project is complete. A market survey and a comprehensive technical review identified three potential applications for SWATH ships on the east coast: a 160-seat passenger ferry, a 1,250-ton scientific research and survey vessel and a 5,500-ton offshore supply vessel. Researchers developed a concept design for each application and identified potential fleet operators.

Cost estimates developed for each of the concept designs were compared with the costs of mono-hull ships having the same capacities, seakeeping abilities and speed. Researchers analyzed the risks and the social and economic benefits involved in introducing SWATH technology to the Canadian east coast.

The results of this project show that SWATH ship technology can be developed in the Maritime provinces. Much of the design technology and production capability already exists. The excellent seakeeping ability of the SWATH ship in rough seas makes it an ideal choice for the Canadian east coast.

Contractor

Eyretechnics (Atlantic) Ltd., Dartmouth, Nova Scotia

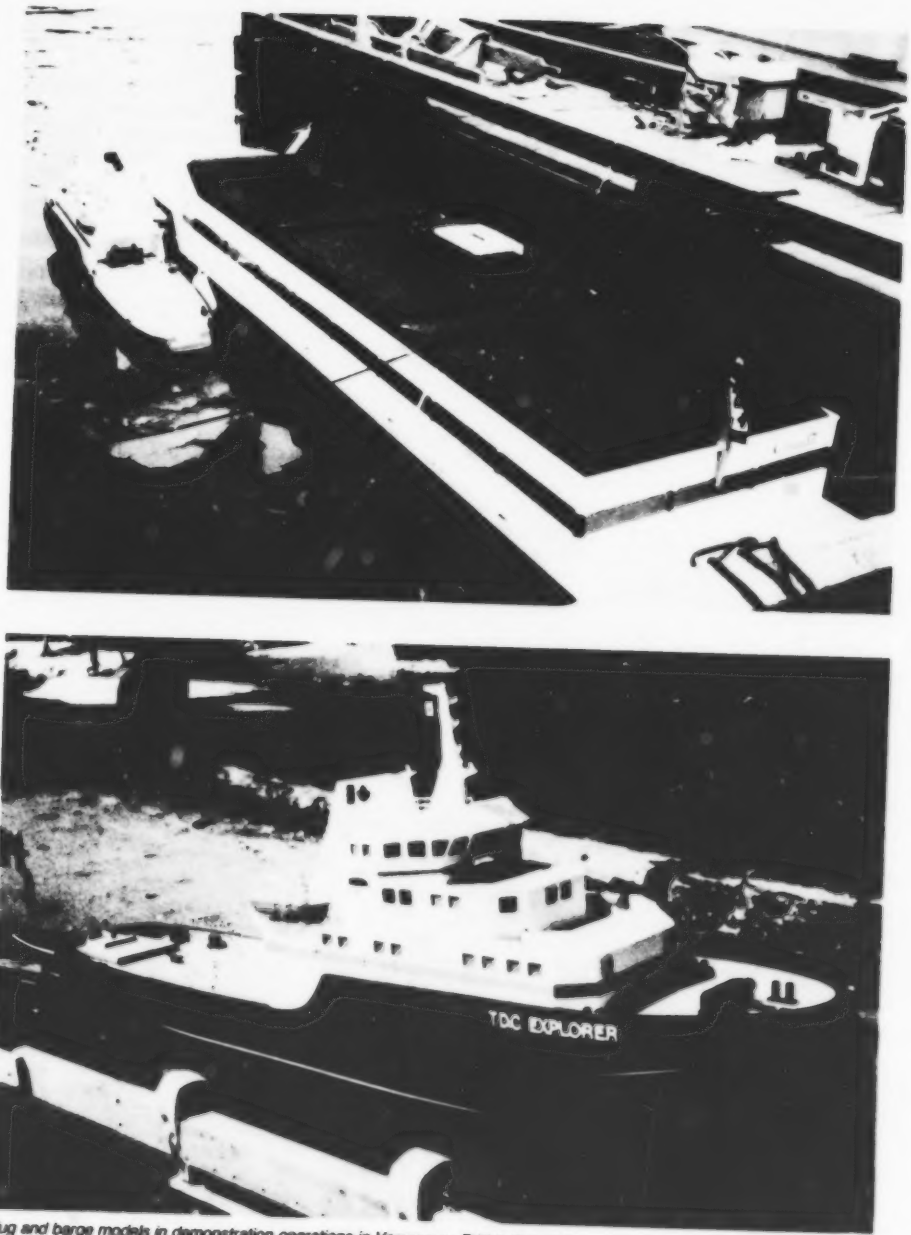
Report

TP 7419E, SWATH feasibility study, Eyretechnics Limited, 1986.

Schedule: June 1985 — December 1985

Funding: TDC —	$ 40,000
NRC —	$ 10,000
DSS —	$ 35,000
DND —	$ 40,000
Total —	$125,000

Project Number: 6452
File Number: D 1460-225
Project Officer: Jacques E. Laframboise



Tug and barge models in demonstration operations in Vancouver, British Columbia

Energy-Effective Tug/Barge Configuration

Description

Tug and barge transportation is widely used by forestry and other resource-based industries in British Columbia. The existing fleet of tugs and barges imposes a cost burden that could be alleviated by more fuel-efficient and refined tug and barge systems.

In 1984, TDC supported the development and evaluation of energy-efficient barge forms and innovative tug features. Specific work on the project included:

- hydrodynamic tank testing of a refined, low-resistance barge form and optimized tug model;
- computer-based parametric analyses;
- mathematical simulations of towline resistance;
- an instrumented test program with the tug/towline/barge system self-propelled in open water; and,
- comparative testing of a self-propelled hull form model.

Progress to June 1986

The project is complete. Researchers have defined an optimum tug/barge system. The barge features a low-resistance hull and skeg to improve towing stability. The tug features a secondary independent propulsion system, consisting of a forward-mounted, 360° "Z" drive propeller below the keel, to provide manoeuvrability when used in conjunction with an efficient single-screw propulsion system.

As part of the development work, a model of the tug/barge system was constructed. The barge model is five metres long and capable of carrying about 1500 kg of payload. The tug model, about two metres long, is self-propelled and radio-controlled. This model is currently being used to demonstrate the innovative tug/barge system to potential users.

Contractor

Seatronics Technologies Ltd., Burnaby, British Columbia

Report

Draft, Development of energy-effective conceptual towed tug/barge systems, Seatronics Technologies Ltd.

Schedule: October 1983 — September 1986
Funding: ADMM — $176,000

Project Numbers: 6102, 6625
File Numbers: D 1460-180-2/3
Project Officer: Ian M. Bayly

Motion Compensation for Marine Crane Operations

Description

Cranes mounted on ships or barges are used to transfer loads between vessels and to place and retrieve navigation buoys, towed arrays and submersibles. In anything other than calm seas, such operations are difficult and hazardous. When the crane itself is in motion, the crane operator cannot easily control the manoeuvring of the cargo. High dynamic loads can overstress the lifting system, and under some conditions the crane simply cannot perform as required.

Stabilized crane platforms present one solution to this problem, but they are expensive. A system that would automatically compensate for the motion of the crane's load could eliminate some of the hazards of sea lifts at a reasonable cost.

The objective of this project was to develop a computer simulation program that will help researchers study crane dynamic loading with motion compensation during sea-lift operations. The results of this work will be used to build and test a model of sea-lift operations using motion-compensated cranes.

Progress to June 1986

The project is complete. A computer program has been developed to permit the real-time simulation of lifting operations. It allows the user to model various sea states, to compute the response of two vessels as a function of sea state, to model a typical crane and its machinery and to model a human operator engaged in lifting operations. Two compensating algorithms were developed. Both offered significant improvement in lifting performance, reduction of operator workload, decreased induced dynamic loads and smaller tracking errors.

Contractor

Hymarc Engineering Ltd., Ottawa, Ontario

Report

TP 7653E, Development and testing of a computer simulation of crane dynamic loading with motion compensation for at-sea lifting operations, Hymarc Engineering Ltd., 1986.

Schedule: May 1985 — April 1986

Funding: CCG —	$15,000
DND —	$15,000
DFO —	$ 5,000
DSS —	$56,585
Total —	$91,585

Project Numbers: 6423, 6427
File Number: D 1460-223
Project Officer: C. Alfred Versailles

Detection of Small Objects at Sea

Description

Canadian offshore activity is increasing. The growth in fishing fleets and petroleum exploration is adding to the proliferation of vessels and structures at sea.

To improve the safety of these operations, new technology is needed for detecting, identifying and monitoring small objects such as boats, life-rafts and survival suits in an ocean environment. Such surveillance technology could also be used as part of an offshore vessel management system.

As a first step in developing a better surveillance system for small objects, TDC supported two projects aimed at investigating existing detection techniques and methods. One project studied airborne search vehicles; the other studied sea-surface platforms and vessels.

The results of this project will be used as a basis for defining components for an appropriate surveillance system.

Progress to June 1986

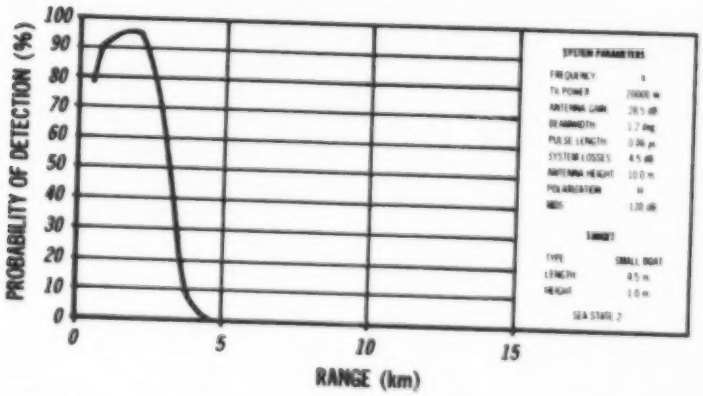
The projects are complete. The study of surface technology concluded that, when visual search is ineffective, radar is the most effective technology for detecting small objects at sea, while infra-red sensors are best for short-range night detection. The study of airborne technology concluded that the most promising sensors are television, forward-looking infra-red, side-looking and forward-looking radar.

Contractors

NORDCO Ltd., St. John's, Newfoundland
F.G. Bercha & Associates Ltd., Calgary, Alberta

Reports

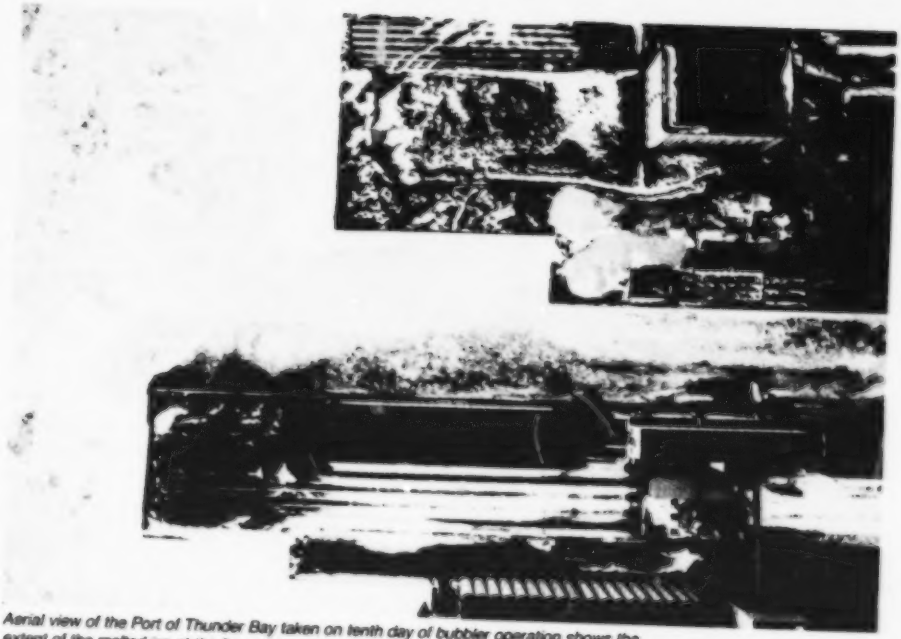
TP 7359E, Evaluation of the technology for detecting small objects at sea: airborne sensor platforms, F.G. Bercha & Associates Ltd., 1985.
TP 6818E, Evaluation of the technology for detecting small objects at sea: surface sensor platforms, NORDCO Ltd., 1985.



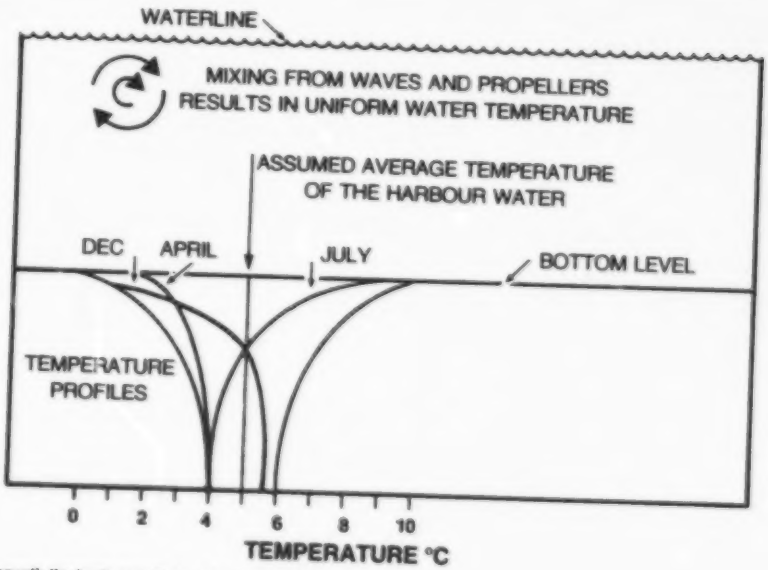
Probability of detection of a small boat using typical marine radar

Schedule: December 1984 — March 1986
Funding: TDC — $20,000
DSS — $34,613
CCG — $25,000
Total — $79,613

Project Numbers: 6344, 6355
File Number: D 1460-220
Project Officer: C. Alfred Versailles



Aerial view of the Port of Thunder Bay taken on tenth day of bubbler operation shows the extent of the melted ice at the face of the slip.



The soil beneath the berth contributes to its thermal reserve.

Permanent Bubbler System Evaluation

Description

Ice frequently blocks port loading berths long after shipping channels are re-opened to navigation in the spring. In an effort to lengthen the effective shipping season, TDC sponsored several studies from 1979 to 1984 aimed at controlling harbour ice. One technique developed uses air bubblers to circulate warmer water from below the surface up to the ice face, thereby speeding the melting process. This bubbler system was found to be technically and economically attractive for the harbour at Thunder Bay, Ontario. The Saskatechewan Wheat Pool installed a permanent bubbler system when it extended its 7A wharf in Thunder Bay in 1984.

The objective of this project was to collect the data required by the Saskatchewan Wheat Pool to assess the efficiency and cost effectiveness of the bubbler system.

Progress to June 1986

The project is complete. The instruments were developed, installed and calibrated in time for conducting tests prior to the opening of the 1985 navigation season. The bubbler system was operated from March 12 to March 22, 1985. Ambient conditions in the test area were monitored both before and during the system's operation. Researchers concluded that the bubbler system was the most cost-effective of several systems previously tested in the area. The tests confirmed the researchers' hypothesis that the thermal reserve available to melt the surface ice exceeds that which is theoretically available in the water of the berth: heat flows also from the soil beneath the berth and from deeper water in the adjacent inner harbour.

Contractor

Arctec Canada Ltd., Kanata, Ontario

Report

TP 6922E, Ice management in Thunder Bay Harbour: performance of a permanent air bubbler system, Arctec Canada Ltd., 1985.

Schedule: February 1985 — September 1985

Funding: TDC —	$ 68,424
ADMM —	$ 60,000
Total —	$128,424

Project Number: 6392
File Number: D 1460-145-2-8
Project Officer: Roy S. Nishizaki

Fibre Optics for Marine Systems

Description

A recent TDC study concluded that fibre optic technology could play a significant role in future shipboard wiring installations. The increased bandwidth capabilities and noise immunity of fibre optic cables could facilitate engine room automation and remote control in an electrically noisy and harsh physical environment. However, more research and some shipboard testing are required before this technology can be applied to marine systems.

The objective of this project is to study the behaviour of fibre optic cables in a salt water environment and to demonstrate the usefulness of the technology aboard a ship.

The results will help establish installation requirements and performance standards for fibre optic cables and components on Canadian Coast Guard ships. This information will be used to formulate procedures for marine use of this technology.

Progress to June 1986

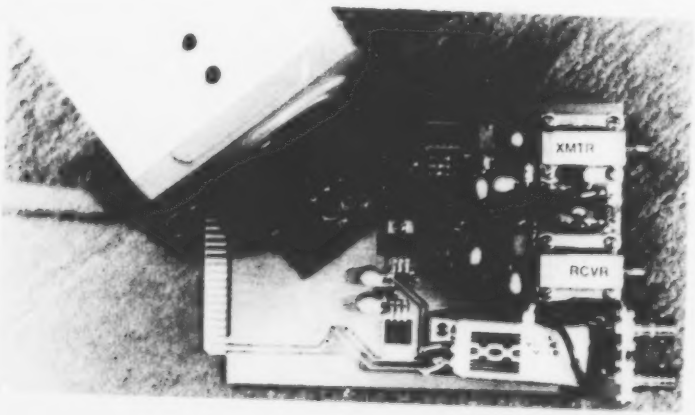
Researchers designed a test system based on an Institute of Electrical and Electronic Engineers specification 488 interface and an off-the-shelf data bus. The system features two end stations, a tap-off bus connection and a configuration for multiple stations along the data-bus. The system was installed aboard the Canadian Coast Guard ship *Louis St. Laurent* in December 1985. An operational demonstration will be conducted during early fall 1986.

Contractor

Focal Marine Ltd., Bedford, Nova Scotia

Report

None to date



Video fibre-optic circuitboard used with Focal Marine's local area network. It has a bandwidth of 10 MHz and is suitable for use in marine and electrically noisy environments.

Schedule: September 1984 — March 1987

Funding: TDC —	$225,000
DSS —	$190,076
CCG —	$ 50,000
Total —	$465,076

Project Number: 6297
File Number: D 1460-198-2
Project Officer: Micha Avni

REPORT LISTING

Report Listing

This is a list of TDC reports published since the previous edition of the project directory. These reports may be ordered free-of-charge from TDC while supplies last.

A comprehensive list of the Centre's reports is given in "TDC Publications" (TP 2602), available upon request from TDC.

Reports may also be borrowed through interlibrary loan from the TDC library in Montreal or from the Transport Canada Library and Information Centre, Transport Canada Building, 2nd floor, Ottawa, Ontario K1A 0N5. The Transport Canada Library and Information Centre provides paper copies of out-of-print reports at a charge of 20¢ per page. Paper copies and microfiches of out-of-print reports are also available at various charges from Micromedia Ltd., 158 Pearl Street, Toronto, Ontario, M5H 1L3, telephone (416) 593-5211.

Rail

Application of fuzzy set theory to risk assessment in the transportation of dangerous goods, by S. Hayto and M. Danard, IBI Group Inc., A. Cubukgil and D. Ross, University of Toronto/York University Joint Program in Transportation, 1985. TP 6505E

Application of fuzzy set theory to risk assessment in the transportation of dangerous goods, summary report, by S. Hayto and M. Danard, IBI Group, A. Cubukgil and D. Ross, University of Toronto/York University Joint Program in Transportation, 1985. TP 6506E

Augmented rail freight transportation research and development program, quarterly and annual reports, by Transportation Development Centre, 1982/83, 1984/85, 1985/86. TP 3756E

Automatic rail car identification, by B. Bouchard and Dr. R.J. Pomeroy, Glenayre Electronics Ltd., 1985. TP 7029E

Bogie prototype, par A.G. Fontaine, Bombardier Inc., 1984. TP 5590F

Bombardier single cylinder medium speed research engine and test facility — phase II: establishment of test facility, by M.L. Payne, Bombardier Inc., 1985. TP 6876E

Canadian railway motive power: performance targets and hybrid benefits evaluation — a working paper, by G.W. English, C. Schwier and J.D. Young, Canadian Institute of Guided Ground Transport, 1984. TP 5380E

CIGGT track research program: interim report, November 1984-November 1985, by S.T. Lamson and C.A. Dixon, Queen's University, Canadian Institute of Guided Ground Transport, 1986. TP 7417E

A computer simulation analysis of electric locomotive sway, by R.J. Anderson and G.W. English, Queen's University, Canadian Institute of Guided Ground Transport, 1984. TP 5585E

Conceptual design of snow removal equipment for main tracks, by A. Van Eyken and S. Perlin, Queen's University, Canadian Institute of Guided Ground Transport, 1984. TP 5289E

Construction au Canada d'une soufflerie aérodynamique à climat contrôlé: étude de faisabilité, rapport sommaire, par J.D. Jackson and V. Uzumeri, DSMA International Inc., 1983. TP 3977F

Container terminal simulation model, summary report, by M.A. MacIsaac, E.D. Brown and I.R. Grunwell, CN Rail, 1984. TP 5759E

Cost benefit study of the electrification of the BC Rail Tacheeda to Prince George line, by J. Popoff, B.C. Rail, 1985. TP 7234E

The cost of rail passenger services in Canada: an examination of institutional problems, by Adil Cubukgil and Richard M. Soberman, University of Toronto/York University Joint Program in Transportation, 1984. TP 5823E

Le coût des services ferroviaires voyageurs au Canada: examen des problèmes institutionnels, par Adil Cubukgil et Richard M. Soberman, University of Toronto/York University Joint Program in Transportation, 1984. TP 5823F

CP locomotive event recorder evaluation, by A.R. Clark, CP Rail, 1985. TP 7240E

CP Rail Toronto Yard noise study, by G.L. Walker, CP Rail, 1985. TP 6723E

Design and development of an automatic lamp changer for railway searchlight signals, by B. Bramwell, Hovey & Associates, 1984. TP 5757E

Design and evaluation of 2-axle steerable locomotive trucks, by W. Pak and D.D. Taylor, Bombardier Inc., 1985. TP 5959E

Design of a single cylinder medium speed research engine and test facility: addendum, by M.L. Payne, Bombardier Inc. 1985. TP 4844E

Design, construction and performance monitoring of electrification poles and foundations on BC Rail's Tumbler Ridge branch line, by J.C. Leighton, BC Rail, 1984. TP 5830E

Design, development and testing of a modified Flyer bus as a railbus, by H.A. Luckhurst and David Gardiner, Winnipeg Coach Sales and Service Ltd., 1985. TP 6912E

Doppler radar locomotive speedometers (radometers) — CMI Inc., field evaluation, by K.H. Kilpatrick, R.J. Lusk and R. Lauzon, CN Rail 1985. TP 6808E

Electric freight locomotive conceptual design, by H. Dorosh, Bombardier Inc., 1985. TP 6799E

Electric locomotive evaluation, by E.R. Corneil, G.W. English and H. Boumeester, Canadian Institute of Guided Ground Transport, 1984. TP 5589E

Electric locomotive evaluation, summary report, by E.R. Corneil, G.W. English and H. Boumeester, Queen's University, Canadian Institute of Guided Ground Transport, 1984. TP 5588E

Electric locomotive performance tests on the BC Rail Tumbler Ridge branch line, by P.H. Bridge, BC Rail, 1985. TP 6203E

Electrification of the Tumbler Ridge branch line, by H. Lockhart, B.C. Rail, 1986. TP 7625E

End-of-train monitoring system, by Dr. R.J. Pomeroy and D. Rees-Thomas, Glenayre Electronics Ltd., 1984. TP 6057E

Establishment of quantitative wear and fatigue model for railway rail subjected to heavy traffic conditions and different lubrication regimes, by J. Kalousek, D. Fegredo, H. Ghonem et al., National Research Council of Canada, 1985. TP 6939E

Étude technique d'un terminal intermodal, rapport sommaire, par C.J.M. Ives, J.C. Dale et al., CP Ltée, 1983. TP 4484F

Évaluation de locomotives électriques, rapport sommaire, par E.R. Corneil, G.W. English et H. Boumeester, Queen's University, Canadian Institute of Guided Ground Transport, 1984. TP 5588F

Évaluation de systèmes embarqués pour la détection de boites d'essieux en surchauffe, rapport sommaire, par K.J.R. Mathewson, R.A.C. DiMichele et F.E. King, DSL Dynamic Sciences Limitée, 1982. TP 4219F

Evaluation of pulsed gas metal arc welding of aluminum, by A. Ditschun, E. Lassaline and B. Zajaczkowski, Welding Institute of Canada, 1986. TP 7432E

Evaluation of the Location, Identification, and Control (LIC) system in an electrified railway environment, by G.D. Taylor, D.O. Gudmundson and E.W. Shaw, B.C. Rail, 1985. TP 7269E

An experimental Ringbom-Stirling engine, by G. Walker and O.R. Fauvel, University of Calgary, 1985. TP 6596E

Fire test to study the significance of a burning relief valve flare from a tank-car engulfed in fire, by A.M. Birk, Davis Engineering Ltd., 1985. TP 6694E

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